

SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

AUGUST 1902.

GENERAL PHYSICS.

1491. *Elastic Properties of Helical Springs.* J. W. Miller, Jr. (Phys. Rev. 14. pp. 129-148, March, 1902.)—This is both a mathematical and experimental paper; brass and steel springs being examined. The static theory of helical springs of Thomson and Tait (Nat. Phil., 1867) is experimentally verified. To a high order of approximation, the force required to elongate a helical spring varies directly as the product of the elongation of the spring and the square of the secant of its slope. When such springs are elongated by an axial pull, with no applied torsional couple, they undergo a twist about the axis of the helix; this twist increases as the pull increases, up to a maximum, and thereafter decreases continuously with increasing pull. The relations of elongation to applied force enable the modulus of twist and the modulus of rigidity of the wire of the spring to be found. The elongations of maximum twist and zero twist enable the ratio, modulus of twist: modulus of bending, to be found. Combinations of these enable the modulus of bending, Young's modulus, and Poisson's ratio to be readily derived.

A. D.

1492. *Flow of Solids.* J. R. Benton. (Amer. Journ. Sci. 13. pp. 207-210, March, 1902.)—The flow of solids is studied by using masses of Wood's fusible alloy, each cast on a framework of soft fuse-wire, melted together at the joints. After deformation, the masses were jacketed with plaster-of-Paris, and the Wood's alloy then melted. The distorted form of the framework was then examined. As compression proceeds, wires at right angles to the plates of the testing-machine take the form of curves with two points of inflexion, and there is a shearing of the whole mass parallel to the plates of the machine.

A. D.

1493. *Plasticity of Clay.* P. Rohland. (Zeitschr. Anorg. Chem. 31. 1. pp. 158-160, 1902.)—After discussing the various views current with regard to the cause of plasticity of clay and similar substances, the author points out that the capability of taking the plastic state is exhibited by such bodies as form colloidal solutions with water. The fact that neither positive nor negative

catalysers will affect the phenomena tends to show that plasticity cannot be due to a hydration reaction. Capillary affinity may possibly account for the more than mechanical combination of water with those substances. A. G.

1494. Cohesion of Liquids. Leduc and Sacerdote. (*Comptes Rendus*, 184. pp. 589-591, March 10, 1902.)—This is measured by two experimental methods, first by the ascent in a capillary tube in vacuum, secondly by a barometer tube. The capillary tube was 0.007 cm. in diameter, and the water rose in it to 48 cm. Since the vapour-tension of water is 19 cm., and since the column preserved without rupture exactly the same height at all degrees of exhaustion, the cohesion is more than the pressure due to 24 cm. of water. Similar experiments with the barometer tube for water and mercury are described. J. W. P.

1495. The Pressure of Vibrations. Rayleigh. (*Phil. Mag.* 3. pp. 838-846, March, 1902.)—The author gives several examples to show how the energy of the vibration of a vibrating system may be drawn off and converted into other forms of work. The first example is as follows: A string is attached at its upper end to a vertical axis, and a ring slides over the axis, including the upper part of the string, the lower part being free. To the lower end is attached a pendulum, which is set swinging. That, by its oscillation, tends to force the ring upwards, any work done in raising it being, of course, at the expense of the vibration energy. If E_1 be the energy when the length of the pendulum is unity it is found that E , the energy of vibration when the length is l , is $E_1/\sqrt{l}$, showing that by raising the ring to an infinite distance the whole energy of vibrations would be exhausted. The next example is that of a stretched string vibrating transversely in a plane, the vibrations being confined between a fixed and a movable ring. This gives analogous results, except that we have here E_1/l instead of $E_1/\sqrt{l}$.

A third example is the vibration of air in a cylinder, Boyles' law being assumed. This also gives analogous results. The author then passes to a more general treatment, showing how Lagrange's equations lead to analogous results, if integrated over a long time T so as to make the integrated term $\frac{1}{T} \int dt \frac{d}{dt} \frac{dq}{dq}$ disappear. The Lagrangian method is applied to the first example of the pendulum, and to more general problems, including Reynolds' theory of the group velocity, and Boltzmann's theory on the application of Carnot's cycle to radiation enclosed within movable reflecting walls. He raises the question whether an analogue of the second law of Thermodynamics can be found in the general theory of the pressure of vibrations, but does not give, apparently, a final answer. S. H. B.

1496. On the Extension of Lagrange's Theorem. P. Duhem. (*Comptes Rendus*, 184. pp. 580-581, March 10, and pp. 686-688, March 24, 1902.)—Certain difficulties which occur in the study of viscous liquids disappear if we assume an adhesion between the liquid and a solid, according to the hypothesis of von Helmholtz and Pietrowski, or, according to the present writer, if the condition of adherence be assimilated to the introduction of new connections. The pressure is then not necessarily normal to the adhering surface—a result which the writer proposes shortly to discuss in a work on the theory of friction. Other difficulties are introduced by the extension of Lagrange's theorem to viscous liquids. The writer refers to a theorem announced by Hadamard, that Lagrange's theorem may be extended to viscous

liquids, at least so long as the motion is analytic. And this theory he claims to have in effect discovered himself. But he has proved (he says) also that no wave can exist in a viscous incompressible liquid of uniform constant temperature. Therefore Lagrange's theorem is applicable at all points of such a liquid, except those which at a given instant have played the part of singular points, or have been on a singular line.

The author mentions several physicists as having applied Lagrange's theorem to viscous liquids. Such a liquid is supposed in the problem to be initially at rest in contact with solid bodies, and to be gradually set in motion. Considering this problem, he arrives at the conclusion "That Lagrange's theorem extended to viscous liquids, is incompatible with the conditions which such liquids have to satisfy on the surfaces of solids." He then puts the question how the difficulty is to be removed. Boussinesq has suggested the following method, to assume namely, "That when a viscous liquid moves from rest at an initial instant ($t=0$), the integrals of the equations of motion which are analytical for positive values of t are in general not analytical for $t=0$." The author is, however, not satisfied with this explanation, and suggests that there may be an imperfection in the theory of viscous liquids to which the difficulty is due. [See also Abstracts Nos. 1288 and 1284 (1902).] S. H. B.

1497. *Transversal Oscillations of an Elastic Sphere*. E. Kohl. (Ann. d. Physik, 7. 3. pp. 516-553, March, 1902.)—This writer investigates an expression for the amplitudes of a spherical wave of torsion, supposed to be expressible in harmonics, advancing through an elastic medium. The oscillations on any wave surface are in parallel circles. He notes that the velocity c , of propagation will, in case of a spherical wave, be a function of the distance r from the centre. It is constant only for a plane wave. The disturbances on the vibrating elastic sphere from which the waves originate are then—

$$u=0, \quad v=\frac{z}{\sqrt{y^2+z^2}} U \sin 2\pi p \left(t - \int_0^r \frac{dr}{c} \right),$$

$$w=-\frac{y}{\sqrt{y^2+z^2}} U \sin 2\pi p \left(t - \int_0^r \frac{dr}{c} \right).$$

From these expressions, solutions are found by the aid of Lamé's integrals, and in terms of the two functions—

$$\Pi'_n(r) = \sqrt{\frac{c_n(r)}{c_0}} \sin 2\pi p \int_0^r \frac{dr}{c_n(r)}, \quad \Pi''_n(r) = \sqrt{\frac{c_n(r)}{c_0}} \cos 2\pi p \int_0^r \frac{dr}{c_n(r)},$$

in which c_0 is the value of c when r is the radius of the vibrating sphere, and $c_n(r)$ satisfies the differential equation—

$$\frac{dc_n}{dr^2} + 4 \left\{ \left(\frac{2\pi p}{c_0} \right)^2 - \frac{n \cdot n + 1}{r^2} \right\} \frac{dc_n}{dr} + 4 \frac{n \cdot n + 1}{r^3} c_n = 0,$$

n being the order of the harmonic. It is then proved that the two Π functions are identical with the R functions of Laersich. Applying the principle of energy, it is found that if at distance r_1 the amplitude is A, then at r_2 it is $\frac{A}{r_2} \sqrt{c_n(r_2)}$. It is explained that the author's results give only the conditions under which the displacements are conformable to the equations of elasticity, and not the manner in which they are created. In the immediate neighbour-

hood of the vibrating sphere there will be, in fact, two systems of oscillation, the first of which, for great values of r , leads to waves advancing with velocity approximately constant, and amplitude varying nearly as $1/r^2$. The second system is attributed to a slipping of the medium over the vibrating sphere, forming as it were an image thereof. The influence on these phenomena of the ratio of the wave-length to the radius of the vibrating sphere is pointed out.

The writer then applies his formulæ to certain numerical calculations, in order to give an idea of the actual form of the wave.

In section 6 is investigated the periods of vibrations for $n=1$, as determining the nature of the emitted spectrum, and the damping of the oscillations. The latter investigation leads to the conclusion that the assumption of very small density for ether makes the constants of damping far too small. Finally, a section is devoted to the consideration of longitudinal oscillations, and the difference between their results and those of transversal oscillations.

S. H. B.

1498. Oscillations of a Disc Immersed in a Viscous Liquid. C. Zakrzewski. (Acad. Sci. Cracovie, Bull. 4. pp. 235-242, April, 1902.)—

The writer assumes Maxwell's theory of viscosity, and its recent developments by Natanson [see Abstract No. 811 (1902)]. The subject has also been treated by O. E. Meyer and Schmidt. The disc is a plane one, suspended by a vertical elastic thread, and oscillates in its own plane in the liquid. It is assumed (1) that no forces act except that of viscosity; (2) that the liquid is incompressible, and the hydrostatic pressure within the liquid constant; (3) that the motion is extremely slow, so that the products of the velocities and their derivatives may be neglected. Under these circumstances, if ψ denote the angular velocity at any point in the liquid, u, v the component velocities of a molecule of the liquid parallel to x and y (the suspending thread being taken for axis of z and the plane of the disc for that of xy), we have $u = -\psi y$, $v = \psi x$, and u and v satisfy the equations—

$$\frac{\partial^2 u}{\partial t^2} + \frac{1}{T} \frac{\partial u}{\partial t} - A^2 \frac{\partial^2 u}{\partial z^2} = 0,$$

$$\frac{\partial^2 v}{\partial t^2} + \frac{1}{T} \frac{\partial v}{\partial t} - A^2 \frac{\partial^2 v}{\partial z^2} = 0,$$

from which is derived "the telegraphist's equation"—

$$\frac{\partial^2 \psi}{\partial t^2} + \frac{1}{T} \frac{\partial \psi}{\partial t} - A^2 \frac{\partial^2 \psi}{\partial z^2} = 0. \dots\dots\dots(1)$$

In these equations T denotes the "time of relaxation" for the liquid, and A the ratio of the rigidity to the density. These results are taken from Natanson's paper referred to above. The writer then takes from Natanson the expressions for the tensions within the liquid, and calculates the forces exerted by the liquid on the disc, with especial reference to the case in which one side only of the disc is wetted (Schmidt's experiment). For a particular solution of the equation (1) he takes $\psi = e^{-m^2 t} \{C \sin(\nu z) + D \cos(\nu z)\}$, where m and ν satisfy the relation $m^4 - m^2/T = -\nu^2 A^2$. The classic equations of hydrodynamics are deducible from this by making $T=0$, and $A^2 T = \eta/\rho$, ξ and η being the displacements of a particle of the liquid parallel to x and y . Dealing with this integral, he obtains the fundamental equation of Meyer and Schmidt.

S. H. B.

1499. *Stability of the Configuration of Equilibrium of a Liquid in a Capillary Tube.* G. Morera. (Accad. Lincei, Atti, 11. pp. 223-228, March 16, 1902.)—Laplace, in his Supplement to the theory of capillary action, states that when the figure of a capillary tube diminishes by very small gradations the successive states of equilibrium are alternately stable and unstable. Matthieu in his theory of capillarity objects to Laplace's reasoning as vague and inconclusive, but according to the present author his own reasoning is equally wanting in precision.

We are to suppose a tube of rotation about a vertical axis. In his notation r is the distance from the axis or any point on the free surface, ρ the radius of the curve in which the free surface cuts the internal surface of the tube, ϕ the angle (supposed obtuse) between the free surface and the internal surface of the tube, i the inclination to the vertical of that surface, and z is the height above a fixed plane. He constructs the curve, called the c curve, $\rho z = -a^2 \cos(\phi + i)$. Then he denotes by σ' the area of the surface of the liquid which is in contact with the tube, and by σ'' the area of the free surface; θ and η are the known constants of capillarity; P is the potential of the capillary forces, dS an element of volume of the liquid at height z , and the density of the liquid is taken as unity. It is found that—

$$P = g \int z dS + \frac{\theta_1 \sigma''}{2} - \left(\eta - \frac{\theta_1}{2} \right) \sigma',$$

the integral being taken over the whole volume of the liquid. This leads to the equation—

$$\partial P = g\pi \int_z^{\frac{z+\partial z}{r(r-\rho)}} z dz,$$

in which r is the distance from the axis, and ρ is the radius of the curve in which the free surface cuts the internal surface of the tube. The test of stability is the sign of $r - \rho$. Hence is derived the conclusion that the stable configurations are those in which, in passing along the c curve upwards, we pass through the meridian section of the tube from outside to inside. The unstable configurations are those in which the passage is from inside to outside.

S. H. B.

1500. *Theory of Errors of Judgment and the Personal Equation.* K. Pearson. (Roy. Soc., Phil. Trans. 198. pp. 285-290, March 14, 1902.)—Two variables x and y may be defined to be correlated, when there exists a third variable, or more than one such, of which x and y are both functions. Professor Pearson divides correlation into two kinds, logically distinct, one of which he brands as spurious. The reasons are given in a former memoir (Roy. Soc. Proc. vol. 60). In the present paper he gives an example of spurious correlation, [which, however, seems itself to be in need of explanation]. A star is observed to pass from A to B through an intermediate point C. Two observers measure the time from C to B in terms [so it is said] of the known time " a " from A to B. And this is done for many stars at different times and the results are found to be correlated. Now if a be really known, and therefore invariable, it may be the unit of time, and to say that both sets of observations are in terms of a is no more than to say that both are expressed in terms of the same unit. Then why and how are they correlated? If on the other hand a , though supposed to be constant is really variable, as if the time were measured by a clock whose rate of going is variable, why is the

correlation spurious? The answer to that question is to be found in the above-mentioned memoir. A definition is given of "personal error" and "personal equation." Personal error may be absolute or relative. If ξ be the true value of the thing observed, x_1 and x_2 , the values given by two observers, then $\xi - x_1$, $\xi - x_2$ are the *absolute*, and $x_1 - x_2$ the *relative* personal errors. They are denoted in this paper by f_{01} , f_{02} , and f_{12} respectively. In many cases the relative personal error is all that can be determined. In addition to his personal error, the merit of an observer depends also on his "stability," or the inverse of that quantity σ whose square is the mean square of the errors in many observations. For two observers the author uses σ_{01} , σ_{02} and σ_{12} . He discusses the current theory of errors, according to which there is a normal, or canonical form of curve, to which it is the duty of any series of observations to conform, namely, that indicated by the exponential $e^{-h\Sigma x^2}$, where the index is the sum of the squares of the errors or deviations from the mean. And evidently the assertion is involved that $e^{-h\Sigma x^2} dx$ is the chance that any given one of the errors shall lie between x and $x + dx$. This law of distribution depends for its existence wholly on the assumption of the mutual independence of the x 's, i.e., on the assumption that the chance for any one error lying between x and $x + dx$ is independent of all the other x 's. The law does not prove the independence, as has been fondly imagined, but merely expresses the independence already assumed as a fundamental axiom. Assuming the normal law to hold, but not otherwise, the author finds for three observers the following simple relations, $2\sigma_{01}^2 = \sigma_{12}^2 + \sigma_{13}^2 - \sigma_{23}^2$, &c. From these, if true, we could determine the absolute from the relative stabilities, which has been a difficulty. For this reason a series of experiments was devised to test the normal law, with the result that the above formulæ were found not to hold.

In section (3) and again in (9) the author doubts the legitimacy of the assumption of independence, even where the x 's are the errors of judgment made by apparently independent observers. And this is perhaps the only one of all the many cases to which the law $e^{-h\Sigma x^2}$ has been applied, in which there is anything to be said for it. In all other cases its use is justified, not by evidence, nor by *a priori* probability, but only by the elquence of the results to which it leads us. The connection to be applied for correlation depends upon the products xx' . For instance, the correlation in absolute judgment between two observers is given by the formula—

$$r_{12} = \frac{\Sigma(f_{01} - \xi - x_1)(f_{02} - \xi - x_2)}{n\sigma_{01}\sigma_{02}}$$

The simplest way of introducing the connection would be to make the index a quadratic function of $x_1 \dots x_n$, and not merely the sum of squares, but Professor Pearson does not go into that question in the present paper. It would involve the undoing of the work which mathematicians have so laboriously done in reducing the quadratic function to a sum of squares. Several experiments were made, in order to measure the intensity of correlation for absolute and relative errors. It is sufficient to describe the first experiment. There were formed 500 groups, each group containing three equal lines, in all three similar series each of 500 lines, but the lines in the same series not equal to each other. To each of three observers was assigned a series, and he marked, according to his judgment, the point of bisection of each line. The results were then compared with the points of bisection actually measured, and the personal errors and correlations tabulated.

The same series were also taken in groups, and the results of the grouped compared with the ungrouped observations, with reference to a paper by Sheppard (London Math. Soc., Proc. p. 368, &c.).

The author then (sec. 7) considers the constancy of the personal equation. And in sec. 9 he again discusses the question of the applicability of the orthodox theory, and the experiments organised to test it. The question he puts is whether the general nature of the distribution of observed quantities is capable of being described by the orthodox curve of errors on the assumption that the observed quantities are taken at random from the "population" of errors which the observers would make if they were to go on with their experiments for an infinite time, or as he calls it a "random sampling."

The result obtained is that, even in this the most favourable possible case for the assumption of independence, that is, for the orthodox law, the supposed accordance, actual or "practical," of a series of observations with the orthodox curve which some writers have persuaded themselves that they see, has no existence. The author summarises his conclusions as follows:—(1) That the personal equation, while tending to a constant value, is subject to fluctuations far exceeding those of random sampling. (2) Observations are "sympathetic," so that there may be correlation of judgments between two observers supposed to be independent. (3) In addition to psychological correlation, there is a spurious correlation arising (he says) when two sets of observations are referred to a common standard. (4) Errors of judgment, absolute or relative, are generally far from being in accordance with the orthodox theory.

And he concludes further (a) That the correlation of judgment is a necessary factor in one appreciation of the personal equation. (b) That we should attempt to find, not only the personal equations of two observers, but also the variations and correlation of their judgments. (c) That the existence of such correlation vitiates the ordinary theory of the credibility of testimony. (d) That great care should be used in applying the orthodox theory, until it be shown that, within the fluctuations of random sampling, the observations really follow the orthodox law. We have no right to assume *a priori* that they do so.

S. H. B.

1501. *Earthquake Waves*. W. Schlüter. (Phys. Zeitschr. 3, pp. 288-242, March 1, 1902. Abstract from Gerland's Beiträgen zur Geophysik, vol. 5, Parts 2 and 8.)—Earthquake diagrams show at first the "preliminary tremors," and afterwards the "large waves" of longer period. The question arises whether the latter are similar to waves on water, involving an oscillation of the normal to the earth's surface about the direction of gravity, or whether they are due to horizontal oscillation of the earth's crust. The author has endeavoured to answer this question by using a seismograph whose centroid is in the axis of rotation, and which therefore is susceptible only to waves of the former class. He calls the instrument a "clinograph," and gives its theory as well as a full description. It detects an angular deviation of 0.02 second. In experiments carried out in the autumn of 1899, when numerous earthquakes were shown by the horizontal pendulum, the clinograph gave no deflection. It follows that neither the "preliminary tremors" nor the "large waves" are due to oscillation of the normal to the earth's surface. Such oscillation either does not exist or is too small to be observed with the modern seismograph.

W. S.

1502. *Baxendell Self-recording Anemoscope*. (Feilden, 8. pp. 245-248, March, 1902.)—A description is given of the J. Baxendell instrument for separate, continuous records of the wind direction in use at the Marshside Station of the Fernley Observatory, Southport. A very light vane, with two blades of aluminium, 80 in. long, joined under an acute angle, is mounted on a tubular steel spindle, 30 ft. above the roof; the vane is conveniently fixed 5 ft. below the vanes of the Dines anemometer. The weight of the vane and spindle is carried on ball bearings. The chart drum rotates with the spindle. A Dines anemometer pen, carried on a vertical rack, drives by its weight a clock; attached to this rack, underneath the holder for the Curtis pen, is a short brass arm, which supports a bevelled metal ring, encircling the chart, in front; the ring, which fits loosely over the chart, sinks a little at the back, and keeps the overlapping end of the paper tight. H. B.

1503. *New Barometric System for the United States, Canada, and the West Indies*. F. H. Bigelow. (Monthly Weather Rev. 30. pp. 13-19, Jan., 1902.)—With January 1, 1902, a new system for the reduction of barometric pressures has been put in operation in the United States, Canada, and the West Indies. As the meteorological stations are at different elevations up to 7,000 ft., and the surface temperatures of a single chart may range between -40° and $+60^{\circ}$, these reduction problems are very important, and this is the sixth attempt made since 1871 to deal with them. The author has perfected Ferrel's system, which was in use for one year in 1886-87. The new planes of reference are the sea-level; the 8,500 ft. plane, the average height of the Rocky Mountains' stations and also of the cumulus base in the eastern states; and the 10,000 ft. plane, already applied to some extent, which is just in the middle of the most rapid horizontal cyclonic and anti-cyclonic currents. Eighteen geographical points, intersections of the 50th, 45th, 40th and 35th parallels of latitude, and the 90th, 100th, 110th, and 120th meridians, are adopted as centres of reduction. The vertical temperature gradient in free air is assumed to be 0.80° F. per 100 ft.; within the Rocky Mountains' plateau it is on average 0.195° F. It follows that, using the smaller gradient up to the plateau, larger values than 0.8° must be employed from the surface to the 10,000 ft. plane if the average gradient is to be 0.8° F. There would, therefore, at the surface of the plateau, be something like an abrupt change in the gradient, which he terms gradient refraction. Charts of normal monthly and annual pressures, temperatures, vapour tensions, and relative humidities have been prepared for the three planes of reference; further charts of gradients of temperature in latitude, longitude, and altitude. The number of stations on the sea-level plane is 265, of stations on the upper planes 175. To facilitate the calculations, the author, in conjunction with Heiskell and Hawkins, has computed logarithmic reduction tables in English measures, for intervals of 100 ft. up to 10,000 ft. and of 10° F. from -40° up to $+100^{\circ}$. H. B.

1504. *Hertzian Waves in the Sun*. C. Nordmann. (Comptes Rendus, 134. pp. 591-594, March 10, 1902.)—The existence of such rays in the sun will explain the aurora borealis and the perturbations of terrestrial magnetism. The periods of the auroræ agree with those of the sunspots. If the sunspots indicate the emission of Hertzian waves, these, striking the rarefied atmosphere, act in exactly the same way as they do when they fall upon a Geissler tube, i.e., produce cathodic phenomena of the well-known kind. The author opposes Arrhenius's explanation of the auroræ by streams of

negatively charged particles. The action of the rays upon the upper layers of the atmosphere affect the atmospheric currents of electricity, to which are attributed the phenomena of terrestrial magnetism. Lastly, it is pointed out that sudden variations of the sunspots, brilliant auroræ, and magnetic storms, are all concurring phenomena. The explanation by Hertzian waves would unite and explain all.

J. W. P.

1505. Motion of the Nebula of Orion. H. C. Vogel. (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 14, pp. 259-266, March 6, 1902.)—Some photographs of the spectrum of this nebula were taken at the end of last and the beginning of this year with the spectrograph No. IV. of the Potsdam Observatory, and, from the displacement of the $H\gamma$ line, the velocity of the nebula was found to be $+17.4$ km. per second. This dispersion of the instrument is such that 0.25 mm. corresponds to a wave-length difference of $0.424 \mu\mu$, and the above velocity is a mean of values obtained by two independent measurements of five plates. The region of the nebula was the same as that previously examined by Keeler, who obtained a mean velocity of $+17.7$ km., namely the well-known trapezium. Some other plates, however, of other portions of the nebula showed a different displacement of the $H\gamma$ line, in particular, one plate containing the spectrum of the nebula close by the star Bond 685. The $H\gamma$ line in this case was distorted, one portion being more displaced than the rest. Evidence is thus furnished of considerable internal motions in the nebula. [See also Abstract No. 1803 (1902).]

E. C. C. B.

1506. Some Results obtained with the Bruce Spectrograph. W. S. Adams. (Astrophys. Journ. 15, pp. 214-217, April, 1902.)—*The variable velocity of α Persei in the line of sight.*—Five plates taken between February 19 and April 8 give a velocity varying from -117 km. per sec. to $+184$ km. per sec. The spectrum is of the Orion type, but the Helium lines are somewhat weak, while the magnesium line $\lambda 4481$ is hardly visible. *The variable velocity of δ Libræ in the line of sight.*—Four plates show a variation in the velocity between $+86$ km. per sec. and -123 km. per sec. The magnesium line $\lambda 4481$ is broad and of moderate strength. The measures of velocity are uncertain by several kilometres. *The radial velocity of Sirius.*—Ten plates gave as a mean value -6.87 km. per sec. for the epoch of 1902.06. From this result and that of -15.6 km. obtained by Vogel and Scheinen for the epoch of 1890.09, a computation of the parallax was made, and found to give $0''.21$, which is rather lower than Gill's heliometric measurement of $0''.31$. *The wave-length of the magnesium line $\lambda 4481$.*—On account of the broad and diffuse nature of this line as observed in the laboratory, it was thought advisable to obtain its wave-length from stellar spectra. After the effects of radial velocity were eliminated, ten plates of Sirius, three of γ Geminorum, and two of θ Leonis gave as a mean value 4481.400 , the extremes being 4481.414 and 4481.382 . This value was used in the determination of the radial velocities of α Persei and δ Libræ given above. [See also Abstract No. 829 (1902).]

E. C. C. B.

REFERENCE.

1507. New Micrometers. W. Weicholdt. (Zeitschr. Instrumentenk., Beib. 6, pp. 53-55, March 15, 1902.)—These are made with wheel and lever motions, and the length is given by the reading of a pointer on a circular scale, the instruments reading directly to from 0.02 mm. to 0.0001 mm.

G. E. A.

LIGHT.

1508. Velocity of Light. A. A. Michelson. (Phil. Mag. 3. pp. 330-337, March, 1902.)—The author discusses the accuracy of the accepted values of the velocity of light, the ratio of the two electrical units, and the velocity of Hertzian waves, and considers that new determinations are necessary. A new method is suggested which is free from most of the drawbacks pointed out by Cornu [see Abstract No. 283 (1902)] and is virtually a combination of the Foucault and Fizeau methods. The light from a slit passes through a lightly silvered glass plate and a lens and falls on the upper half of a revolving mirror. It is reflected to a grating which reflects to the lower half of the mirror, and the beam passes by way of a lens to the distant mirror. By this arrangement the author hopes that the velocity may be determined to within 5 km. or less.

G. E. A.

1509. Images formed by a Parabolic Mirror. H. C. Plummer. (Royal Astron. Soc., Monthly Notices, 62. pp. 352-369, March, 1902.)—The above forms a first paper containing the geometrical theory of the subject, and including criticisms of previous papers by Tennant, Schaeberle, Crockett, and the author. It results that it is impossible to effectively overcome the aberration of a parabolic mirror by any of the usual devices, and "the more or less kite-shaped images are unavoidable in the case of a reflector as ordinarily adapted for photographic use." Parabolic mirrors for a definite purpose may be designed by aid of the equations given.

G. E. A.

1510. Refractive Power of Mixtures. A. Leduc. (Comptes Rendus, 134. pp. 645-646, March 17, 1902.)—It is known that this is conserved in mixtures in which there is no combination. Damien found that this was the case in mixtures of glycerine and water; the author now finds the same with alcohol and water.

A. D.

1511. Mechanical Equivalent of Light. K. Ångström. (Phys. Zeitschr. 3. pp. 257-259, March 15, 1902.)—The total radiation of a Hefner lamp is determined by means of the author's compensation pyrheliometer (Wied. Ann., 1899), the value found being 0.00129 gr. cal./min. at 1 m. distance. To measure the visible radiation, a spectrum is produced, and the invisible rays are cut off. The visible part is brought through a cylindrical lens and a water cell to a photometer, and balanced against the direct light from a similar source. On replacing the photometer by a bolometer or thermophile, the ratio L/Q of the energies in the two beams is found to be 0.90 per cent. $\pm$ 0.04 per cent. Hence the "mechanical equivalent" of unit intensity of illumination is 8.1 erg./sec. per sq. cm. at 1 m. distance. The value $L/Q = 5.5$ per cent. was found for an acetylene lamp, and is about half that found by Stewart and Hoxie. Recalculation from Stewart's numbers corrects an error and gives L/Q a value between 5 per cent. and 6 per cent.

G. E. A.

1512. Intensity of Radiation in connection with the Earth's Motion. H. A. Lorentz. (Konink. Akad. Wetensch. Amsterdam, Versl. 10. pp. 804-809, March 29, 1902.)—It has been suggested by Fizeau that, provided the ether does not

share the earth's motion, there should exist a notable difference in the intensity of radiation emitted by a source of light or heat placed on the surface of the earth, according to its direction coinciding with, or being opposite to, the direction of the velocity v of the earth, a vibration starting from L having to traverse a path $lc/(c-v)$ or $lc/(c+v)$ respectively, where l is the velocity of light. Now the author shows, by an approximate calculation, that the current theories of electrical and optical phenomena in moving bodies may account for the negative results given by any experiments intended to verify Fizeau's suggestion. In fact, in the expression developed for the energy of radiation, the velocity of the earth is found not to occur.

A. G.

1513. Table Photometer and Standard Pentane Burner. F. Clowes. (Soc. Chem. Ind., Journ. 21. pp. 818-815; Discussion, pp. 815-816, March 15, 1902.)—The author describes the newly-adopted apparatus used in the London Gas-testing stations, and shows the different improvements made, in order to insure more accurate testing of the illuminating value of the gas used in London. The standard lamp is a 10-candle-power one, and is arranged to burn air which has been carburetted by admixture with the vapour of pentane, and advantage is taken of the high specific gravity of pentane vapour (2.5, compared with air) to make the supply to the flame automatic. The mixture of air and pentane vapour is burnt from a steatite argand ring, and the circular flame is fed inside with air which has been heated by passing between two long, concentric, chimneys placed immediately over the flame. The pentane which is used in the carburettor is prepared from light American petroleum, by purifying the fraction which distills over at 45° . The new lamp furnishes a more convenient, and a much less variable, standard than that yielded by candles. The paper is fully illustrated, showing the lamp in section and front view. The table photometer differs in two important respects from the ordinary bar photometer, when it is used for testing the illuminating power of coal-gas. The observer is seated on one side of the semi-transparent screen, and both sources of light are placed at fixed distances upon the other side. Further, the equating of the light from the different sources is effected by the adjustment of the gas supply to the test burner, instead of by altering the distance of either source of light from the screen. The distances between the screen and the pentane lamp and gas-burner are carefully adjusted by means of rods of standard lengths, and the relative positions of the burners are also similarly adjusted. The apparatus is also made portable. A diagram shows the arrangements for fixing the apparatus.

L. G.

1514. Reversal of Photographic Image. M. I. Wilbert. (Frank. Inst., Journ. 153. pp. 231-235, March, 1902.)—Experiments are described on long exposure and development in diffused daylight, with production of positives instead of negatives. The result is as if the long exposure had produced a faintly visible negative image, and this image protected the film under it from further action of light; and as if the developer was therefore able to act more energetically upon the portions of the film previously less exposed.

A. D.

1515. Magnetic Rotatory Polarisation in Absorption Bands. O. M. Corbino. (N. Cimento, 8. pp. 121-132, Feb., 1902.)—The author's conclusion that the

rotation within a sodium band was in the same direction as outside it was challenged by Professor Voigt. The author has again experimented, and come to the same conclusion, opposed to theory though this be. The amount of rotation is small, but is approximately proportional to the strength of the field. [See also Abstracts Nos. 36 and 465 (1902).] A. D.

1516. Selective Absorption as a Function of Wave-length. G. E. Hale. (Astrophys. Journ. 15. pp. 227-228, April, 1902.)—In photographs, published in a previous paper [see Abstract No. 1596 (1902)], of the spark spectrum of iron in water, it was to be seen that the reversals first appeared at the more refrangible end of the spectrum, and as the conditions became more favourable, lines of greater wave-length became reversed. Similar results were obtained with titanium, magnesium, cadmium, copper, nickel, cobalt, lead, and aluminium. Selective absorption thus appears to resemble general absorption. This is interesting in view of Campbell's discovery that in the spectra of certain stars the ultra-violet lines of hydrogen are dark, while those of greater wave-length are bright. Frost has suggested an explanation of such spectra on the assumption that the law of selective absorption resembles that of general absorption, as also has Kayser in more detail. [See Abstract No. 649 (1902).] E. C. C. B.

1517. The Band-Spectrum of Nitrogen. C. Cuthbertson. (Phil. Mag. 8. pp. 848-858, March, 1902.)—Deslandres has shown that the bright lines of the second group of this spectrum ($\lambda = 5,000$ to $\lambda = 2,820$) conform to a law that the interval between one line and the next are approximately in arithmetical progression. The author shows that the first group ($\lambda = 6,622$ to $\lambda = 5,000$) obey somewhat the same law. The oscillation frequencies of the heads of the bands fall into thirteen series, some of which contain only two numbers. The difference in frequency between the first two numbers of the first series is 1,681; this difference between the first two numbers falls in arithmetical progression down the series to the thirteenth, where it is 1,129. Similarly, also, the differences between the members of each series fall in the same arithmetical progression. By this arrangement certain anomalies are accounted for. It is noteworthy that the arithmetical progression of the above is the same as that of Deslandres for the second group, and begins where that left off. E. C. C. B.

1518. A Personal Equation in Measuring Photographic Spectra. B. Hasselberg. (Astrophys. Journ. 15. pp. 208-213, April, 1902.)—In measuring wave-lengths by comparison and interpolation between lines in the solar spectrum, very distinct differences were observed between the values obtained when readings were made from red to violet, and when from violet to red, the difference being greatest, about 0.083 tenth meter, when a spectrum of the arc was compared with that of the sun. The effect is a physiological one depending on a tendency to misjudge the centres of bright and dark lines in juxtaposition on a plate. An effect of the same magnitude, but in the opposite sense, has been noted by Reese. E. C. C. B.

1519. Standard for Röntgen Rays. G. Contremoulins. (Comptes Rendus, 134. pp. 649-651, March 17, 1902.)—Apparatus is described, analogous to a photometer, for comparing the light on the fluorescent screen with light derived from an acetylene flame, and also for testing the penetrative power of the rays by means of adjusting the position of a wedge of metal interposed, while the above comparison is being carried out. A. D.

1520. *Induced Radio-activity.* A. Sella. (Accad. Lincei, Atti, 11. p. 57, Jan. 19, and pp. 242-245, March 18, 1902.)—A zinc or aluminium spiral surrounds a tinfoil-lined axial cylinder of cardboard pierced by many needles thrust through it; the spiral and the core are respectively connected with the terminals of an induction electrical machine; then, whether the spiral be positive or negative, it is strongly radio-active. Tesla's transformer does not produce nearly the same effect as the electrostatic machine.

A metallic body becomes radio-active when points are made to face it, and points and body are connected to the poles of an electrostatic machine, with a condenser in derivation, for, say, an hour. The distance between the points and the metallic body is made such that there is an effluvium but no sparks. The metallic body becomes radio-active, even when its charge is positive, provided that the air is fresh air, not the stale air of a room closed for some hours, but not even in fresh air unless there be plenty of room round the metallic body; but all metals act equally. If the metallic body be connected to the machine and the points to earth, after some time, the metallic surface becomes altered and shows Kundt's figures. If the experiment be carried out in stale air (box closed for sixteen hours), charged with the emanations from thorium oxide, the radio-activity induced is very great (ten times that induced in the open air), and is the same whether the metallic body be charged positively or negatively, but is greater with a negative than with a positive charge when the access of air is unrestricted, though it is comparatively small in this case. In the open air, a negatively charged metal has its side turned away from the more powerfully charged points. In stale air charged with thorium emanations the side farther from the points is not more radio-active than it would have been in any case in presence of these thorium emanations. With the more powerful radio-activity developed as mentioned, the photographic plate showed Kundt's lines splendidly. Kundt's lines show up on the metallic surface when this is brought into air containing smoke or magnesia dust. On connecting the body and points with the terminals of a Tesla transformer, there is no induction of radio-activity in stale air containing thorium emanations.

A. D.

1521. *Radio-activity and the Electron Theory.* W. Crookes. (Roy. Soc., Proc. 69. pp. 418-422, March 21, 1902.)—Electrons emanating from radio-active bodies behave like material particles, and are impeded by the molecules of the surrounding medium, in contrast with ether waves, which are not thus affected, except by absorption. The author describes experiments in proof of this statement. Actinium (which the author incidentally states to be identical with the body which he called Uranium X in his Royal Society paper of May 10, 1900) and radium give electrons which partake of the properties of a fog or mist of material particles, capable, when not kept in by a thick metal screen, of diffusing away in the free air like odoriferous particles, but the behaviour of polonium is different as regards this diffusibility. Radium emanation may be carried away by a current of air passing over the metal. It will also pass through aluminium and a considerable length of air, and then affect a sensitive film, but experiments on this point with polonium show that air offers great obstruction to penetration by its emanation. Strutt [see Abstract No. 1646 (1901)], has suggested that while the penetrating deflectable Becquerel rays are generally recognised as consisting of a stream of negative corpuscles with high velocities, the non-deflectable and absorbable rays are positive ions moving in a stream from the radio-active body. On this hypothesis, corpuscles from polonium might consist of heavy positive

ions, and the author is now making experiments to test the accuracy of this inference. The author has shown in a previous paper ("Electrical Evaporation," Roy. Soc., Proc. 50. p. 88, June, 1891), that many bodies, such as silver, gold, platinum, &c., usually considered non-volatile at ordinary temperatures, easily volatilise in a vacuum if connected with the negative pole of an induction coil, but remain fixed when connected with the positive pole. When a silver pole was used in a tube of very high vacuum ($P = 0.00068$ mm.), and a sheet of mica, with a hole in its centre, placed in front of it, then when the poles were connected with the coil, the silver being negative, electrons shot from it in all directions, and, passing through the hole in the mica screen, formed a bright phosphorescent patch on the opposite side of the tube. After continued action of the coil for some hours it was found that silver had been deposited only on the mica screen and in the immediate neighbourhood of the pole, while the far end of the tube, which had been kept glowing for hours from the impact of electrons, was free of silver deposit. Accepting Strutt's view that positive as well as negative corpuscles will fly off from a radio-active body, we have here two simultaneous actions. Electrons were shot off from the negative pole, and caused the glass on which they impinged to glow with phosphorescent light. Simultaneously, the heavy positive ions of silver, freed from their negative electrons, or under the influence of electrical stress, also flew off, and were deposited in the metallic state near the pole. Experiments were made to see whether these metallic ions, thus deposited on a metal plate connected to an idle pole, in the full stream of + ions and - electrons, showed any special + or - electrification. In all cases the electrification was positive, thus lending support to the view of Strutt, although this result must not be taken as conclusive, for the author has previously shown that, at a high vacuum, nearly the whole of the interior of a tube through which an induction spark is passing is electrified positively.

W. C. H.

1522. *Radiography*. E. W. H. Shenton. (Roentgen Ray, Archives, 6. pp. 62-70, March, 1902.)—An interesting description is given of surgico-medical routine in radiography as carried out at Guy's Hospital, with an eye to simplicity and the safety of the patient. The need is emphasised of plenty of light, and the practical unimportance of "definition." A. D.

1523. *Diagnosis of Thoracic Aneurysm by Röntgen Rays*. H. Walsham. (Roentgen Ray, Archives, 6. pp. 70-74, March, 1902. A paper read at the meeting of the Röntgen Society, June 6, 1901.)—Relates three cases in which the Röntgen rays revealed the existence of aneurysms of the aorta, which were not diagnosed by the ordinary methods of auscultation. Aneurysms of the aorta give abundant evidence of their existence when an examination of the chest is made by Roentgen-ray photography. Often they can be plainly seen by a screen examination. The method should never be omitted in cases of doubtful chest diseases. Eighteen illustrations are given. L. J.

REFERENCE.

1524. *A Method of Obtaining Stereoscopic Effects*. E. W. Caldwell. (Elect. Rev. N.Y. 39. pp. 601-603, Nov. 16, 1901.)—A description is given of the means employed to obtain a stereoscopic image in the fluoroscope used in Röntgen-ray work. Two tubes, or a Röntgen-ray tube with a double focus, are employed. J. J. S.

HEAT.

1525. *The Bunsen Ice-calorimeter.* G. Lindner. (Phys. Zeitschr. 3. pp. 237-238, March 1, 1902. Communicated by the Physik. Institut der Universität von Erlangen.)—Bontschew (Inaugural Dissertation, Zurich, 1900) has stated that successive experiments with the same specimen show a gradual decrease in specific heat if the ice calorimeter is used. The author proves that this is due to avoidable experimental errors; if the ice formed covers the whole of the tube containing the specimen, and care is taken that it is not below zero, the instrument is thoroughly reliable. In Bontschew's experiments it is probable that there was no ice covering the bottom of the tube, and hence the heat given up by the specimen was not used solely in melting the ice. W. S.

1526. *Heating by Condensation of Steam.* H. Claassen. (Zeitschr. Vereines Deutsch. Ing. 46. pp. 418-425, March 22, 1902.)—The details of the transfer of heat through a metallic surface from saturated steam on the one side to a boiling liquid on the other are here studied. No general formula can be given for the transmission-coefficient, owing to the complexity of the effect produced by the variation of any one condition; but the author's general conclusions from elaborate experiments are that this coefficient increases with the temperatures of the steam and of the liquid, and with their difference, but decreases when the height of the liquid column above the heated surface increases, and with rise in the degree of superheating (if any) of the steam. The mechanical condition of the separating surface, apart from rust and scale, and the substances dissolved in the water, have also great influence on the coefficient; thus sugar and organic substances lower it, the effect increasing with their concentration, while salt solutions raise it.

R. E. B.

1527. *Specific Volumes of Oxygen and Nitrogen Vapours at the Boiling-point of Oxygen.* J. Dewar. (Roy. Soc., Proc. 69. pp. 360-366, March 7, 1902.)—These values having never hitherto been directly ascertained, this preliminary paper records results of determinations of the vapour densities by actual weighing in spherical glass flasks of 300 c.c. capacity, capable of withstanding pressures up to 5 atmospheres; the necessary precautions and corrections are discussed, and an explanation given of the abnormal figures obtained by Behn by indirect methods. Six determinations at the boiling-point of oxygen, taken as 90.5° absolute, have given as the mean weight of oxygen per litre 4.428 grms., and the specific volume 225.82, numbers which are believed to lie within $\frac{1}{2}$ per cent. of the true value. Taking Regnault's density of oxygen at 0° and 760 mm., the density at 90.5° would normally be 0.0048137, and the specific volume 231.82, which is 1.0246 times the average observed volume, showing that $p v$ is diminished at the boiling point of oxygen by 2.46 per cent. While the ratio of the absolute temperatures is 3.017, the ratio of the densities is 3.091. Further experiments at the same temperature with reduced pressures showed that the ratio of the change of density is greater than that of the change of pressure. Six determinations with nitrogen vapour at 90.5° , and at rising temperatures, proved that its specific volume at 90.5° is 256.838, from which it is calculated,

from the formula $T = v \cdot 90.5/256.888$, that, at its own boiling-point of 78° absolute, it would be 221.8 , as against 226.2 , the similar value found for oxygen. In the case of hydrogen, the next of these values to be accurately ascertained, there will be great manipulative difficulties at 21° absolute, and, as the pressure in the weighing flask will be nearly 15 atmospheres, it will be advisable to construct it of some metal or alloy [see also Abstracts Nos. 1288 (1901) and No. 45 (1902)].

S. R.

1528. Cooling by Liquid Air. d'Arsonval. (Soc. Int. Élect., Bull. 2. pp. 177-208, March, 1902.)—The author gives first a brief historical *résumé* of the means employed for reaching low temperatures, and describes in detail Linde's apparatus for producing liquid air. In this, air is compressed to 220 atmospheres and allowed to expand; the machine differs from Hampson and Tripler's in that these employ one expansion while Linde employs two, the first to 50 atmospheres and the second to atmospheric pressure. By using this double expansion, Linde was able to diminish the size of his compressor to one-fifth of that required in Hampson and Tripler's apparatus. The author then describes the flasks with vacuum jackets used for keeping liquid air, and states that the small quantity of heat which reaches the inner vessel does so by conduction across the junction between the two vessels. He then deals at length with the properties of liquid air and the uses to which it can be put, and describes experiments made by Armagnat and himself on the magnetic properties of iron and steel at the temperature of liquid air. Bar magnets of Alleward steel were found to lose their magnetism to a small extent in cooling from $+10^\circ$ to -190° C.; the percentage loss varied from 1.3 to 4.25 in different specimens. A table is given for values of H and B for a ring of soft iron, at $+10^\circ$ and -190° C. For low values of B the permeability is less at the lower temperature, while for B above 15,000 it is slightly greater. The heat of vaporisation of liquid air is found by the author to be 65 calories. He measured also the specific heat of air at -100° C. at different pressures; the figures obtained are:—

Pressure in atmospheres ...	10	20	88	75
Specific heat	0.2585	0.284	0.375	0.866

[See also Abstract No. 468 (1902).]

G. H. B.

1529. Cooling Power and Conductivity of Air. P. Compan. (Comptes Rendus, 184. pp. 522-524, March 3, 1902.)—This is a continuation of previous work [see Abstract No. 808 (1902)]. In a blackened metal flask, 14.5 cm. in diameter, for temperature differences from 800° to 0° , the cooling power of air at pressures between 50 mm. and 4,480 mm. (6 atmospheres) is represented by Dulong and Petit's formula $np^b t^c$, where $b = 1.28$ and $c = 0.45$, values the same as those found by Dulong and Petit for pressures smaller than the atmospheric. The formula also represents the cooling power of air as affecting a ball in an indefinitely extended medium. When the air has a movement of translation, velocity u , its cooling power is $kt\sqrt{u}$, as Boussinesq predicted (Comptes Rendus, 183. p. 257).

A. D.

1530. Melting of Binary Solid Mixtures by Cooling. Bakhuis Roozeboom. (Konink. Akad. Wetensch. Amsterdam, Versl. 10. pp. 727-781, March 29, 1902.)—The phenomena corresponding to the passage of mixtures from one state of aggregation into another are much more complicated than those exhibited by a single substance, the order of those states being sometimes inverted.

The first example known is the retrograde condensation of a solid separating out by evaporation and dissolving again. The author's theoretical study on transformations of binary solid mixtures [see Abstract No. 679 (1900)] suggested to him the possibility of similar phenomena; the case of mixture crystals separating by cooling into a solid and a liquid phase was, however, not realised until now, as adequate examples were missing. Now, De Kock having met with a most striking example of mixture crystals in the liquid state, in the case of mixtures of azoxyanisol and hydroquinone, the author considers very fully the phenomena exhibited by those systems, maintaining that this case of retrograde solidification (provided the liquid crystalline state be regarded as solid) may be no exceptional one. He finally points out the similar case of solid mixture crystals discovered recently by Heycock and Neville [see also Abstract No. 1382 (1902)]. A. G.

1531. Cryoscopic Researches. P. Chroustchoff. (Jurn. Russk. Fizik. Chimičesk. Obsčestva, 84. 2a. pp. 153-182; and 8a. pp. 323-350, 1902.)—The method of measuring temperatures by means of an electric thermometer, as suggested by the author, is found to be the most sensitive, accurate, and certain method of investigating the lowering of freezing-points of solutions, its main advantages being its sensitiveness to less than 0.0005° , and its being capable of still further perfection by simple alterations. An additional advantage is that the results are obtained as temperature differences. The lowering coefficient C/P , and therefore the molecular lowering CM/P as well, is dependent upon the degree of dilution in a manner which varies with different aqueous solutions. The laws of variation of this coefficient do not confirm the views of Arrhenius of a direct analogy existing between these phenomena and those of dissociation [see also Abstract No. 413 (1901)].

A. G.

REFERENCE.

1532. The Second Law of Thermodynamics. K. v. Wesendonck. (Ann. d. Physik, 7. 3. pp. 576-583, March, 1902.)—This is a contribution in support of the author's views and in criticism of Wiedeburg's. [See Abstracts Nos. 80 and 2128 (1901).]

R. E. B.

SOUND.

1533. *Singing Pipes*. C. Maltézos. (Comptes Rendus, 184. pp. 701-708, March 24, 1902.)—At the embouchure of a pipe there is an inrush of air below so long as the pipe is sounding, as well as an outrush of air above. This inrush seems to be continuous with the outrush, so that NH_4Cl smoke or tobacco smoke drawn in by the inrush below will emerge by the outrush above. The inrush is periodically intermittent. If any air-currents in the neighbourhood of the embouchure be hampered, the pitch of the pipe alters.

A. D.

1534. *Air-Pressures in Brass Instruments*. E. H. Barton and S. C. Laws. (Phil. Mag. 8. pp. 885-898, April, 1902. Paper read before the Physical Society, Dec. 18, 1901.)—The instruments examined were the tenor trombone, the trumpet, and the cornet, and the relationship of pressure of blowing to the pitch, intensity, method of fingering and nature of the instrument was investigated. The pressure was read by a water manometer connected to the performer's mouth by an indiarubber tube and glass nozzle. This, after some practice, did not inconvenience the player. Tables of figures and curves are given showing the results when any three of the four variables mentioned above are kept constant, and the fourth is allowed to have its special connection with the air-pressure exhibited. The following results are arrived at:—(1) The louder the note the greater the pressure; (2) the higher the pitch the greater the pressure; (3) for a given intensity, the pressure is approximately proportional to the logarithm of the frequency; (4) alternative methods of fingering have practically no effect on the pressure required, pitch and intensity being kept constant; (5) the pressures for cornet and trumpet are almost the same, the same note being produced at the same intensity; the pressure for the trombone is very much greater.

J. W. P.

1535. *Decimal Scale for Music*. A. Guillemin. (Comptes Rendus, 184. pp. 980-982, April 28, 1902.)—The author proposes to replace the octave and the comma (the usual large and small units of interval) by the savart and the millisavart, defined as follows: The savart to be the interval 10:1 (equivalent to 3 octaves and a major third) and the millisavart the thousandth part of this, *i.e.*, the interval given by the thousandth root of 10:1 or approximately 435 to 434. With these units all calculations will be much simplified. The formulæ giving any interval m to n in terms of the savart and the millisavart will become respectively $\log \frac{m}{n}$ and $1000 \log \frac{m}{n}$, replacing, in the old notation, the expression $(\log \frac{m}{n}) / (\log \frac{2}{1})$ in terms of the octave, and $(\log \frac{m}{n}) / (\log \frac{81}{80})$ in terms of the comma. The tempered semitone is very nearly 25 millisavarts, and the millisavart, although not appreciable by the ear as an interval, may be easily apprehended by the beating, at the rate of one per second, of the notes 435 and 434, which lie in a convenient part of the scale. It is also proposed, as a consequence of these results, that the standard international fork should be taken as 434.8.

J. W. P.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

1536. *Asymmetry of the Electro-capillary Curve.* J. J. van Laar. (Konink. Akad. Wetensch. Amsterdam, Versl. 10. pp. 753-769, March 29, 1902.)

—(1) An accurate theoretical consideration of the capillary electrometer shows that the surface-tension expressed in terms of the charge of the double stratum is not represented adequately by the equation $\gamma = q_0 - k\omega^2$, but by the more complicated relation $\gamma = q_0 - A\omega - (k + \beta)\omega^2$. (2) The coefficients A and β are not equal, in the case of the solution being charged negatively, to their values in the case of an equal positive charge; in the former case $k + \beta$ is more than double those values, A being negative in the former, positive in the latter case. (3) The electro-capillary curve consists of two parabolic branches entirely different from each other, contiguous in the case of $\Delta = 0$, the rising branch being much more abrupt than the falling branch. (4) The rising branch will exhibit a maximum, not necessarily corresponding to $\Delta = 0$; for the example tested, the difference is as large as 40 millivolts. (5) This proves sufficient to account for all such peculiarities of the electro-capillary curve as had hitherto remained unexplained. (6) According to (4), Lippmann's capillary electrometer fails to afford an adequate means of determining the exact value of the potential difference between a metal and an electrolyte. A. G.

1537. *Loss of Life by Lightning in the United States.* A. J. Henry. (U.S. Weather Bureau, Bull. 30. pp. 7-21, 1901.)—The statistics cover the eleven years 1890 to 1900; but as the compilers had largely to rely upon newspapers and clipping bureaux, the inquiry was abandoned at the end of 1900. From 700 to 800 people were killed each year, 713 persons being killed by lightning in 1900, and 973 injured. The Middle Atlantic States and the Ohio Valley, further Tennessee and the Middle and Upper Mississippi Valley are most endangered; the mortality is very high in the Middle Rocky Mountains, considering the sparsity of the population. The main body of the bulletin is taken up by general remarks on thunderstorms and their dangers, partly reproduced from bulletin 26. There are notes on electric duststorms with abundant but noiseless flashes of light, and two weather maps of the United States, the one of July 8, 1898, showing thunderstorms south-west of a low-pressure area, and the other of June 25, 1901, thunderstorms in an area of high pressure. H. B.

DISCHARGE AND OSCILLATIONS.

1538. *Influence of Dielectric on Spark-length.* S. Lussana and P. Carnazzi. (N. Cimento, 8. pp. 182-188, Feb., 1902.)—On bringing up a strip of glass until its upper edge stands between the centres of two spark-gap spheres, if it be close to the anode, the ratio δ between the new spark-length and the original spark-length increases rapidly at first, and then less rapidly, with the thickness of the glass. As the glass is moved further from the anode the values of δ increase, reach a maximum, and fall back to unity. On

increasing the diameter of the spheres, the values of δ increase. As potential-differences rise, the values of δ fall, reaching unity. Other dielectrics act in similar ways. On making the spark pass from a sphere to a liquid the results are similar. A small insulated conductor has no such effect up to or near the anode. A. D.

1539. *Spark Spectra of Iron in Liquids, and in Air at High Pressures.* G. E. Hale. (Astrophys. Journ. 15. pp. 182-185, March, 1902.)—In these experiments, of which this is a preliminary account, the spectrum of the iron spark has been investigated, both when the discharge is under water or various solutions and also when in air at different pressures. The current was obtained from a 15,000-volt transformer, and the discharge was made between steel electrodes 1 mm. in diameter and about 1 mm. apart; an auxiliary spark-gap 12 mm. long was also used in series, and a condenser of about 0.0015 microfarad capacity. A series of photographs is reproduced showing the spectrum of the spark in water and salt solutions and in other liquids. Under certain conditions many of the principal lines are reversed, this being especially marked when such liquids as kerosene are employed, or salt solutions, the maximum effect being produced in a 9.5 per cent. solution of BaCl_2 . Within limits, the reversals increase in number and intensity: (1) with length of auxiliary air-spark; (2) with the diameter of the electrodes of either spark; (3) with the capacity of the condenser; (4) with the pressure of the water; (5) with the concentration of the solution, when sodium chloride or other salts are dissolved in the water. On the other hand, an increase in the length of the spark tends strongly to diminish the reversals. In addition to the above, no reversal is to be found in the following cases. The spark in a Wehnelt interrupter (iron rod in potash solution with a direct current of 110 volts). The arc between rotating iron poles in water. The spark from a large Apps coil between iron poles in water. The discharge from a high frequency coil between iron poles in water. The blue region of the spectrum of the transformer sparks in air has also been observed at pressures up to 20 atmospheres. Results were obtained in agreement with those of Humpheys and Mohler at lower pressures; the lines remain sharp, and are shifted towards the red by an amount which seems to be proportional to the pressure. The phenomena are thus quite different from those observed in water. A series of photographs are also reproduced showing the transition from the bright line to the dark line spectrum; these were taken with a 21-ft. grating with the spark in water under varying conditions. E. C. C. B.

1540. *Asymmetry in Alternate-current Discharge.* W. Mitkiewicz. (Jurn. Russk. Fisik. Chimičesk. Obsčestva, 84. 2b. pp. 17-29, 1902.)—These researches were undertaken with the view of testing the asymmetry of alternating currents traversing a gaseous medium between electrodes of different character. The author accordingly studies the case of the voltaic arc produced by a direct current between two such electrodes; the back electromotive force being determined by a direct-compensation method. The results obtained agree fairly well with Duddell's data in order of magnitude, but are much inferior to those of other observers. The slight differences found to exist, according to the direction of the current, may very well explain the small dissymmetries shown by an alternate-current arc less than 1 mm. in length, but fail to account for those corresponding to Blondel's second régime. It is therefore suggested that selective conductivity may play a considerable part in those phenomena, the medium once traversed by a discharge opposing a

greater resistance to discharges occurring in the opposite direction. The work of previous observers is very fully discussed, and tables are given for the back e.m.f., these values ranging from 6 to 17 volts in the cases considered.

A. G.

1541. Kathode Rays. G. Leithäuser and E. Warburg. (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 14. pp. 267-269, March 6, 1902.)—When we use the homogeneous rays from an influence machine, not from an induction coil, we find that passing them through a thin lamella of metal renders them non-homogeneous and diversely deviable, so that they may form a magnetic spectrum.

A. D.

1542. Electrical Oscillations in Coils. E. Lüdin. (Ann. d. Physik, 7. 3. pp. 584-588, March, 1902.)—Following Hertz, it is usual to generate electric vibrations by spark discharges. They are, however, equally obtainable on opening or closing a simple circuit containing a battery and a coil of a sufficient number of turns. This result may be deduced theoretically by noting that the coil has capacity. The oscillations were experimentally detected by a coherer attached to, and projecting from, one end of the coil. The effect was more marked on opening than on closing the circuit. By this arrangement stationary waves were also obtained along a wire, their presence being shown by well-marked nodes and anti-nodes detected by the coherer. The coil used was in five sections, and had in all 2,823 turns, a resistance of 12.85 ohms, and an inductance 0.166 henry. Currents from 0.1 to 0.8 ampere were used. The author feels that the effects here investigated may afford the explanation of some of the disturbances experienced at the receiving station in Marconi telegraphy, the mechanism there used probably generating waves which affect the coherer.

E. H. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1543. Contact Differences of Potential between Amalgams and Electrolytes. L. Poincaré. (Comptes Rendus, 184. p. 527, March 3, 1902.)—Referring to a paper by P. Boley [see Abstract No. 1105 (1902)], the author mentions having described a capillary electrometer for measuring the contact differences of potential between amalgams and electrolytes before the French Association for the Advancement of Science at the congress held at Marseilles in 1891. The author obtains certain curious results with an amalgam of tin in the presence of sulphuric acid; for this amalgam, the value of the e.m.f. which makes the capillary constant a maximum is practically zero at ordinary temperatures, consequently, an electrometer constructed with this amalgam gives readings independent of the sign of the applied e.m.f.

E. C. R.

1544. Change of Electrical Conductivity of a Powder by Induction. H. Muraoka and T. Tamaru. (Ann. d. Physik, 7. 3. pp. 554-561, March, 1902.)—Following up the work of Sundorph [Abstract No. 1717 (1899)], the authors experimented with a circuit containing a battery, galvanometer, and the powder under test. The change of conductivity of the powder consequent upon closing a shunt-circuit through it was noted. Sundorph found an increase of conductivity in iron and nickel, which he attributed to fusion of the particles. The present authors thought the effect might have a magnetic origin, and therefore tried brass and carbon dust. The brass gave the same

effect as the other metals, but the carbon the opposite effect. A theory is then developed mathematically, and tested by further experiments on brass dust; an approximate confirmation of the chief result being obtained, viz., that the reduction of the resistance of the powder is smaller, the smaller the inducing current, and the greater the volume of the powder. E. H. B.

1545. *Electrostatic Relay*. V. Crémieu. (Comptes Rendus, 184. pp. 524-526, March 3, 1902.)—If a circuit contact cannot be made by pressures less than some centigrammes' weight, and if supplementary pressures be added to the initial pressures in a registering mechanism, there is a tendency to solder the contacts together, and to make the pull-off difficult. The electrostatic relay now described, for use with the author's absolute electrometer, obviates these difficulties by making connections through an electrostatic quadrant. This gets rid of sparks. A. D.

ALTERNATING CURRENTS AND MAGNETISM.

1546. *Action of Alternating Currents on Direct-Current Armatures*. L. Fleischmann and A. Orgler. (Elektrotechn. Zeitschr. 23. pp. 258-260, March 27, 1902.)—The authors simplify Latour's explanations [see Abstract No. 334 (1902)] of the effects produced by passing alternating currents through ring-wound direct-current armatures. The case of an alternating current sent through two brushes diametrically opposite to one another on the commutator is first considered. It is shown that, whatever the speed with which the brushes are made to rotate round the commutator, the impedance between them is constant. This is proved analytically, and illustrated graphically by diagrams giving the values of the currents at various instants in the coils for different positions of the brushes. The case of four rotating brushes placed at equal distances apart round the commutator, the brushes being connected to a two-phase system of supply, is next considered, and the problem is solved on the ordinary sine assumptions. It is shown that the impedance between an opposite pair of brushes is a function of the speed with which the armature rotates. When the armature-speed is in synchronism with the period of the alternating current then the impedance is the same as the resistance, and hence the reactance is zero. It is thus possible to excite the iron of the core in exactly the same way by means of two-phase currents as by means of direct-current field magnets. The applications of this by Heyland are mentioned [see also Abstract No. 502 (1902)]. A. R.

1547. *The Rectified Alternate Current*. A. Gerschun. (Phys. Zeitschr. 3. pp. 249-254, March 15, 1902.)—This is a theoretical investigation, the e.m.f. in the circuit being a rectified sine e.m.f. The curve representing the e.m.f. in terms of the time is thus obtained by rotating the negative part of the usual sine curve through 180° about the time axis. The expression for the e.m.f. is a Fourier series proceeding by even multiples of ωt , where ω is 2π times the frequency of the primary rectified current. Solution of the differential equation of current for a single circuit with self-inductance leads to the following results: The mean current depends solely on the resistance; if the circuit possesses any inductance, the instantaneous value of the current is never zero; the amplitude of the current fluctuations is the smaller, the larger the time-constant of the circuit; the current curve is symmetrical with

respect to its maxima and minima; the lag of the current can be only approximately calculated. Those results are easily confirmed by observations with a Braun tube and rotating mirror. The author finds also the ratio of the effective current as indicated by an electromagnetic continuous-current ammeter to the instantaneous current; the greater the self-inductance the more nearly does this ratio approach unity, and for zero inductance it is approximately 1.11. With zero inductance Mitkiewicz [see Abstract No. 2486 (1901)] has found the ratio to be as high as 1.7, which is due to deviation of the e.m.f. from the sine form and to complications introduced by the rectifier. If the circuit contain capacity as well as inductance, we get an alternating current of mean value zero; no compensation of inductance by capacity is possible as it is with ordinary alternating currents. In view of Zenneck's experiments [see Abstract No. 190 (1900)] the author considers also the case of an ideal transformer whose primary contains the rectified sine e.m.f., using Heaviside's method of symbolical solution of the differential equations. The current in the primary is a pulsating current whose instantaneous value is never zero and whose amplitude is smaller the smaller the resistance of the secondary. The current in the secondary is alternating, and its theoretical value is in complete agreement with Zenneck's found by experiment. Zenneck thought that his results were due to deviation of the e.m.f. from the rectified sine form, or to hysteresis, or to complications caused by the rectifier, but in reality they are the necessary consequences of a rectified sine e.m.f. in the primary.

W. S.

1548. Accurate Measurement of Large Phase-Differences. M. Breslauer. (Zeitschr. Elektrotechn., Wien, 20, pp. 58-57, Feb. 2, 1902.)—For the measurement of power-factors of the order of 0.1, a wattmeter is unsuitable, since even under the most favourable conditions, viz., when the pressure and current coils are both loaded to their full capacity, the available part of the scale becomes reduced to $\frac{1}{10}$, and when the conditions are less favourable, to a still smaller fraction of its full range. A very large error must under these circumstances be expected. The author describes the following arrangement, which has given very satisfactory results. The inductive load is joined in series with a non-inductive resistance, as in the 8-voltmeter method, and two readings are taken with a suitable differential galvanometer (or electromagnetic voltmeter), one of whose coils is arranged as a shunt across the non-inductive, and the other across the inductive, part of the circuit, the connections of either coil being reversed for the second reading. The first reading measures the geometrical sum, and the second the geometrical difference, of the p.d.'s across the inductive and non-inductive parts of the circuit. By reasoning similar to that employed in connection with the 8-voltmeter method, it is easy to show that if e_s and e_d be the readings (in volts) of the differential instrument in the two cases, and r the value of the non-inductive resistance, then the power in the inductive part is given by $(e_s^2 - e_d^2)/4r$. The author gives examples of measurements by this method, which are very consistent with each other.

A. H.

1549. Magnetostriction of Nickel-Steel. H. Nagaoka and K. Honda. (Comptes Rendus, 184, pp. 586-588, March 3, 1902.)—The anomalous thermal expansion of the alloys of nickel and iron adds interest to this research. The alloys have the following percentage of nickel:—(a) 25 per cent.; (b) 29 per cent.; (c) 36 per cent.; (d) 46 per cent. These letters will be used below. *Variation in Length.*—(a) Not sensibly magnetic, no length change,

(b) sensibly magnetic, varies in length slowly with field; (c) strongly magnetic, varies at first rapidly, but soon approaches a limit; (d) is intermediate between b and c in properties. *Variation in Volume*.—This becomes less as the alloys are more strong in nickel. It is significant, as showing how little thermal changes influence these observations, that whereas c has a coefficient of thermal expansion about one-tenth as much as b and d, its variations in dimensions are intermediate between those of the other alloys. [See also Abstract No. 879 (1901).] P. E. S.

1550. *Magnetostriction of Nickel-Steel*. C. E. Guillaume. (Comptes Rendus, 134, pp. 538-539, March 3, 1902.)—This paper refers to the foregoing research of Nagaoka and Honda. The smallness of the changes observed leads one to think that the result may be due to purely thermal causes. If susceptibility increases with temperature, we should expect, using Carnot's principle, that any increase in field would be accompanied by elevation of temperature. L. Dumas has propounded the theory that for the alloys having a small percentage of nickel, the magnetism is like that of iron; but that for alloys with more than 25 per cent. of nickel, the magnetic properties will be like those of this metal. At first sight the results of Nagaoka and Honda seem in direct opposition to the theory of Dumas. But as this theory is so satisfactory in other ways, the author considers that fuller research, taking temperature change into account, will very likely confirm it. P. E. S.

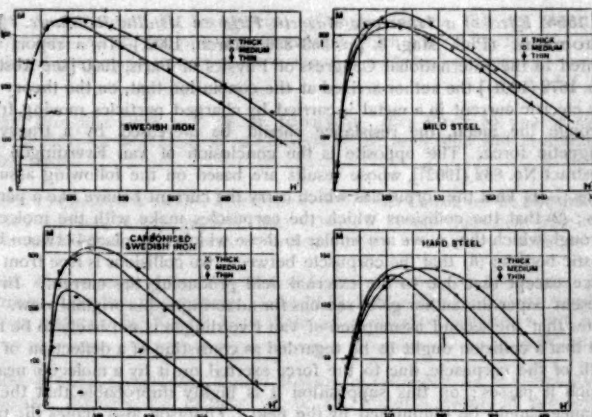
1551. *Magnetostriction of Nickel-Steel*. F. Osmond. (Comptes Rendus, 134, pp. 596-598, March 10, 1902.)—The author points out that Dumas's theory fails, as Guillaume shows, in reference to the research of Nagaoka and Honda (see preceding Abstract), and also in two other ways. (1) The exceptional dilatation of certain of the alloys can only be explained by supposing that a contraction of one constituent opposes the expansion of another, due to the gradual transformation of crystalline constituents. (2) The magnetic power of these alloys (*i.e.*, those having reversible magnetism) is much too great to be attributable to nickel alone. P. E. S.

1552. *Stability of Magnetism, Temporary and Permanent*. M. Ascoli. (N. Cimento, 3, pp. 5-70, Jan., 1902.)—This is an exhaustive paper, in which the author traces out an area within the area of the hysteretic diagram, within which inner area the magnetisation is not affected by shock. A permanent magnet perfectly stable to shock may always be obtained by adjusting magnetisations and demagnetisations, the experimental methods involved being in practice relatively easy to carry out. The percentage of permanent magnetism which must be sacrificed in order to secure stability under shock is greatest for iron, least for tempered steel; and it is almost independent of the magnetising force applied. In iron it is about 65 per cent., and does not depend on the form of the iron; with steel it varies from 7 to about 20 with the form of the metal; with tempered steel it varies from about 0.2 to about 0.9 per cent. In tempered steel, even though the magnetisation be not uniform, it is possible to attain approximately perfect stability in all points of the metal. A. D.

1553. *Magnetic Expansion of Iron and Steel*. P. E. Shaw and S. C. Laws. (Electrician, 48, pp. 699-702, Feb. 21; and pp. 765-767, March 7, 1902.)—This paper deals with the continuation of experiments previously described in the Electrician [see Abstract No. 1381 (1901)], which were carried out by the aid of Shaw's Electric Micrometer [see Abstract No. 523 (1901)]. The

materials investigated were : (1) Swedish iron ; (2) mild steel ; (3) hard steel. In each case rods of diameters 5 mm., 4 mm., 3 mm., 2 mm., 1 mm., and $\frac{1}{2}$ mm. were employed. The true magnetising force H' is given by the relation $H' = H - NI$ where $H = 4\pi ni$, and N is a constant depending on the length and diameter of the rod. The values of N for cylinders and rods are given in Du Bois' "Magnetische Kreise," having been worked out experimentally for all the sizes employed by the authors. From the equation given $H' = 4\pi ni (1 + Nk)$, where k is the magnetic susceptibility, the susceptibility is found by the ballistic method, the materials being made into rings, and welded with the greatest care to preserve continuity at the joint.

To obtain the value for H' the following process is employed. Assume a value for H' , and from the susceptibility curve for the specimen find the corresponding value for k , hence $1 + Nk$ is known, and dividing this into the uncorrected value for H , viz., $4\pi ni$, a value for H' is obtained. If this agrees with the assumed value of H' this value is adopted. If not, proceed by



taking a fresh value for H' and so on until the two values of H' agree. The results obtained are given in the curves, M , the alteration in length, being in cms. $\times 10^{-7}$, the length of the specimens is about 8.5 cm., and the diameters 5, 4, and 3 mm. The conclusions obtained are thus summarised: Even if the chemical composition of specimens be identical, and they be repeatedly annealed from a temperature of bright redness, there is found an irregularity of behaviour which indicates that the ultimate molecular structure is very heterogeneous. Regularity of expansion is obtained when a reading under like conditions has been repeated many times. This shows that the cause of the irregularity is in the particles, which gradually take up a definite position under definite treatment. If H be the field required to produce the maximum elongation, and a field H' greater than H be put on, the rod first expands and then contracts. When the field is put off, the rod expands again to its maximum, and then contracts to its stable state. Thus the rod undergoes every stage in expansion up to the point in question, and does not take a short cut as might be expected. This effect is to be attributed to the self-induction of the magnetising coil, whose time constant is large enough to allow the rod to expand progressively as the field changes. E. C. R.

1554. *Magnetisation at -185° C.* C. C. Trowbridge. (Phys. Rev. 14. pp. 181-191, March, 1902.)—Dewar and Fleming (Proc. Roy. Soc. 1896) investigated the effect on the magnetic moment (M) of suddenly cooling steel magnets to -185° C. The author magnetises at -185° , by placing the steel bars in liquid air surrounded by an air jacket round which is a coil. He then compares their values of M with those of the same bars magnetised at 20° . He also raises the cooled and magnetised bar to 20° , and determines any resulting change in M . His conclusions are: (1) Approximately the same M is obtained in carbon—or tungsten—steel, whether the bar is magnetised at 20° or at -185° . (2) The initial loss in M , due to change in temperature, of a bar magnetised at -185° and then heated to 20° , is much greater than when the bar is magnetised at 20° and cooled to -185° . (3) A certain amount of unstable magnetism exists, which tends to pass off at the first change in temperature, either way; but much more passes by heating than by cooling. P. E. S.

1555. *Effect of a Transverse Magnetic Field on Metallic Resistance.* J. J. Thomson. (Phil. Mag. 8. pp. 853-856, March, 1902.)—In a report presented to the International Congress of Physics at Paris, 1900 [see Abstract No. 1672 (1901)] the author arrived at the conclusion that, on the theory that the electric current in a metal is carried by charged particles moving freely through the metal, the resistance should be increased by a transverse magnetic force. The opposite is the conclusion of van Everdingen [see Abstract No. 862 (1902)], whose results are based on the following assumptions:—(1) That the corpuscles which carry the current behave like a perfect gas; (2) that the collisions which the corpuscles make with the molecules through which they move are similar to those which take place between hard elastic bodies; (3) that the corpuscle between two collisions is free from any force except that due to the external field producing the current. In the present paper the author gives reasons for adhering to his original view. He states that the second assumption of van Everdingen is not likely to be true, but that a collision ought to be regarded as consisting of a deflection of the path of the corpuscle, due to the force exerted on it by a molecule near to which it passes; on this supposition it is highly improbable that the resistance should be diminished by the field. Thomson also denies the truth of van Everdingen's third assumption. The corpuscles are highly charged, and are always within distances of less than 10^{-7} cm. of the molecules of the metal; it is almost certain, therefore, that the local forces exerted on the corpuscle by the surrounding molecules are enormously greater than those exerted by the external electric field, and that at the end of its free path the corpuscle rushes into or past the molecule with which it is colliding with a velocity very large compared with that with which it started. The result obtained by van Everdingen was deduced from hypotheses leading to large values for quantities which, though uncertain as to magnitude, are undoubtedly very small. W. S.

1556. *Magnetic Observations at Potsdam, 1890 to 1899.* G. Lüdeling. (Phys. Zeitschr. 8. pp. 203-207, Feb. 15, 1902. From Abhandlungen des Königl. Preuss. Meteorolog. Instituts. 1. No. 8. p. 54, 1901.)—Attention is drawn to the vector diagrams of the original. The distinction of summer and winter semesters is less instructive than Lloyd's grouping into winter, summer, and equinoctial months (March, April; September, October). The horizontal components show a double annual period with maximum about

the summer solstice, secondary maximum about the winter solstice; the vertical and total intensity a single period, maximum in February, minimum in June-July. The secular variations seem to indicate that we are approaching a turning-point, but the registering instruments are not very reliable. The declination is decidedly decreasing, but may continue to do so for 120 years. A table is added of the chief magnetic disturbances; they correspond with the auroræ, and, if taken, not singly, but for the whole year, with the sunspots.

H. B.

REFERENCES.

1557. *Condenser Effects with Rotating Disks*. **A. G. Dell**. (Elect. World and Engineer, 89, pp. 550-551, March 29, 1902.)—A brief account of some further experiments on the behaviour of rotating disks when electric sparks are passed underneath them parallel to the plane of the disks. [See Abstracts Nos. 1310 (1901) and 1343 (1902).] W. C. H.

1558. *Ionised Gases*. **P. Langevin**. (Comptes Rendus, 134, pp. 414-417, Feb. 17, 1902.)—An account of some experiments which confirm the theory of the ionisation of gases, and a theoretical discussion of some deductions from the theory. J. J. S.

1559. *Disruptive Discharges*. **K. R. Johnson**. (Écl. Électr. 30, pp. 385-389, March 15, 1902.)—A short paper in continuation of the work dealt with in Abstract No. 1097 (1901). E. H. B.

1560. *Propagation of Electric Vibrations in Water*. **E. Cohn and P. Zeeman**. (Archives Néerlandaises, 7, pp. 1-9, 1902.)—This is a French translation from the Konink. Akad. Wetensch. Amsterdam, Verslagen, 1895. G. W. DE T.

1561. *Measurements of the Absorption of Electric Vibrations in Electrolytes*. **P. Zeeman**. (Archives Néerlandaises, 7, pp. 10-27, 1902.)—This is a French translation from papers in the Konink. Akad. Wetensch. Amsterdam, Verslagen, 1895 and 1896. G. W. DE T.

1562. *Reiniger, Gebbert, and Schall's Mercury-jet Interrupter for Induction Coils*. **H. Boas**. (Elektrotechn. Zeitschr. 23, p. 208, March 6, 1902.)—In this paper references are given to various publications with a view to showing that this type of interrupter [for which see Abstract No. 1103 (1902)] was known early in 1898. C. K. F.

1563. *The Induction Coil*. **W. Rollins**. (Elect. Rev. N.Y. 40, pp. 406-411, March 29, 1902.)—Practical directions are given for the construction of a 70-cm. induction coil suitable for the powerful currents needed in wireless telegraphy and in Röntgen-ray work. The secondary coil is made up of separate sections and contains only 13 kg. of copper. A. D.

1564. *Form Factor and Amplitude Factor*. **G. Benischke**. (Zeitschr. Elektrotechn., Wien, 20, pp. 157-169, March 30, 1902.)—A paper in which the author considers the relative importance of these two factors, and arrives at the conclusion that the amplitude factor is more important than the form factor. A. H.

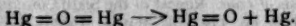
1565. *Magnetic Tests of Iron*. Report of the Sixth Commission. **H. Armagnat**. (Soc. Int. Élect., Bull. 2, pp. 172-176, March, 1902.)—Suggestions are drawn up as to the several details about which care should be taken in commercial tests on permeability and hysteresis. The suggestions form the basis of a discussion to take place at the next meeting. [See also Abstract No. 1482 (1900).] P. E. S.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1566. *Calculation of Atomic Weights.* J. Schmidt. (Zeitschr. Anorg. Chem. 81. 1. pp. 146-154, 1902.)—It is assumed that chemical attraction obeys the universal laws of attraction between particles of matter, i.e., is a force proportional to the product of the weights of the effective masses. The author next suggests that to every equivalent value of an atom there corresponds a definite part b of the atomic weight, in addition to a portion chemically un-effective a , wanting in the case of hydrogen only. Monovalent atoms are hence represented by $a + b$, bivalent by $a_1 + b_1 + b_2$, and so on. In order to calculate these quantities a and b , it is presumed that in the case of the elements of the two first series, viz., in the case of those atoms which possess greatest chemical energy and least proper weight, there exist the most simple numerical relations. The values for the atomic weights thus calculated for these, and for the two following series, are in very satisfactory accordance with those found by experiment. Conclusions are drawn from a comparison of the calculated atomic weights with molecular volumes. A. G.

1567. *Atomic Weight of Antimony.* G. C. Friend and E. F. Smith. (Chem. News, 85, pp. 124-125, March 14, 1902. From Journ. Amer. Chem. Soc. vol. 23, No. 7.)—The paper describes application to antimony of the authors' new method of heating a potassium or sodium salt in dry HCl, and weighing the residual alkaline chloride, by which they lately determined the atomic weights of molybdenum and arsenic. Very carefully purified antimonyl potassium tartrate was placed in a small porcelain crucible enclosed in a larger one with two holes in the lid, and very cautiously heated in a steady stream of pure dry HCl gas, the temperature finally reaching dull redness. Oxygen was passed to remove the carbon, and then again HCl. Platinum crucibles could not be used, as they were very severely attacked. The atomic weight of antimony, as deduced from the weight of potassium chloride remaining, was, in eight experiments, maximum 120.885, minimum 120.811. Barium and silver antimonyl tartrates crystallise well, but have not given satisfactory results by this method. S. R.

1568. *Valency of Oxygen and the Halogens.* H. Stanley. (Chem. News, 85, pp. 188-184, March 21, 1902.)—A theoretical paper supporting the thesis that these elements can assume a higher valency than the normal (quadrivalent in oxygen and trivalent in the halogens), especially in compounds having like atoms combined, and in which there is a lower stability. A parallelism is drawn between hydrazoic acid HN_3 , ICl_3 , and the (as yet) hypothetical HI_3 from KI_3 . In peroxides and acids, such as chloric and nitric, which easily lose one atom of oxygen, this atom is considered to be attached by two bonds to a quadrivalent oxygen, which latter returns to its normal dyad character after the decomposition. A formula of this character, $\text{Et}_2\text{O} = \text{O} = \text{O}$, had been already suggested by Collie for ethyl peroxide. The breaking-up of mercurous oxide is represented as—



Arguments in favour of the proposed new formulæ are deduced from the increasing stability in the series of oxyacids of chlorine, the dissociation of ICl_3 , and the existence of complex fluorides. S. R.

1569. Atomic Weight of Calcium. T. W. Richards. (*Zeitschr. Anorg. Chem.* 31. 2, pp. 271-275, 1902.)—Most uncertain data have hitherto been current as to the atomic weight of calcium, in spite of its wide distribution. In order to obtain pure calcium chloride, the author transformed some Rutland marble into the nitrate, and purified it by repeated crystallising. From the specimens thus obtained the carbonate was precipitated by pure ammonium carbonate, this product being next transformed into the chloride. The precautions used in analysing the latter are described, the results showing that three specimens tested were almost identical. The mean value 40.126 obtained for the atomic weight agrees closely with the value 40.142, derived from the recent measurements of Hinrichsen, carried out without any knowledge of the author's work. Further investigations by other methods are being made at Harvard College. A. G.

1570. Classification and Atomic Weights of Neon, Argon, Krypton, and Xenon. H. Wilde. (*Comptes Rendus*, 134. pp. 770-772, April 7, 1902.)—Recent determinations of the densities of these gases show that they belong to the series $H \times 7n$, which includes nitrogen, in a table of the elements arranged with atomic weights in multiple proportion, n being for argon 8, for krypton 6, and for xenon 9. Since there is considerable difficulty in purifying neon, and its density is abnormal, the atomic weight is taken as $H \times 7$, n being one, the author considering that 9.96, the density found by Ramsay and Travers, makes the atomic weight too high. [See also Abstract No. 2415 (1901).] S. R.

1571. Micro-Crystalline Structure of Platinum. T. Andrews. (*Roy. Soc., Proc.* 69. pp. 433-435, March 21, 1902.)—The author's examination of the etchings produced on the surface of polished platinum by immersion for a short time in boiling aqua regia shows that the crystalline structure of this metal appears to generally resemble those of gold and silver. The photographs taken, reproductions of which accompany the paper, exhibit clearly both large, or primary, crystal grains and secondary, or very minute, crystals. The primary grains consist of irregular polygons of varying size, the etched indications of the facet junctions being in many cases clearly and sharply defined. The minute crystals are arranged in varied orientations in the mass, but the orientation is generally identical, or on the same plane within the area of each larger crystal grain. The general micro-crystalline structure of platinum is allotropic in character, and is derived from a system of interfering cubes and octahedra, the cubic and hexagonal forms being frequently noticeable. The large, or primary, grains vary from about 0.002 to 0.04 in. in size, and the smaller from about 0.0002 to 0.007 in.; it seems probable, from observations made, that the secondary crystals are each built up of even more minute crystalline particles. From the researches of Liversidge on platinum nuggets, there appears to be considerable identity between the crystalline structure of natural platinum nuggets and that of the ingot employed by the author. T. H. P.

1572. The Significance of Changing Atomic Volume. II. The Probable Source of the Heat of Chemical Combination. T. W. Richards. (*Amer. Acad., Proc.* 37. pp. 399-411, Feb., 1902, and *Zeitschr. Phys. Chem.* 40. pp. 597-610, May 13, 1902.)—It is shown that the relation between heat of chemical action and change in atomic volume, as suggested in a previous paper [see Abstract No. 2430 (1901)], is very close. Taking chlorine as a non-metal with a large coefficient of compressibility, and comparing the heat

of formation of a series of metallic chlorides, with the contraction that occurs, the correspondence appears to indicate the existence of a fundamental relationship between the two phenomena, and the law is formulated that "the work needed for the compression involved in the formation of one solid or liquid by the combination of two others, is approximately proportional to the heat evolved." A hypothetical interpretation of this law is given, which also explains the mechanism of the heat of absorption, adhesion, and change of allotropic form. The evidence obtained is strongly in favour of the hypothesis of compressible atoms, and the far-reaching effects of this theory on many physical, chemical, and astro-physical problems are pointed out.

S. R.

1573. *Union of Hydrogen and Chlorine. The Draper Effect.* J. W. Mellor and W. R. Anderson. (Chem. Soc., Journ. 81. 82. pp. 414-418, April, 1902.)—The Draper effect consists in the sudden expansion and immediate subsequent return to its original condition of a mixture of equal volumes of hydrogen and chlorine, when acted on by the light from an electric spark. The authors describe the best means of demonstrating this effect, and they find also that hydrogen chloride is formed during the phenomenon, which is only produced by the luminous rays of light. The effect occurs with mixtures of approximately equal volumes of hydrogen and chlorine, but not with the latter alone, or when mixed with steam, air, nitrogen, carbon dioxide, carbon monoxide, or methane. The amount of combination taking place between the two gases depends, not only upon the number, but also upon the intensity, of the sparks, and when the effect reaches a certain magnitude depending on the "sensibility" of the gas, explosion occurs, and this appears to be a large Draper effect. The motion of the index fluid which occurs when the insolation vessel of Bunsen and Roscoe's actinometer is exposed to a flash of light, appears to be brought about by some disturbance in the gas attending chemical combination.

T. H. P.

1574. *Invisible Liquid-layers. Surface-tension of Liquid Precipitates.* G. Quincke. (Ann. d. Physik, 7. 3. pp. 681-682, March, 1902.)—The ferrocyanides of copper, cobalt, nickel, and iron are first obtained as supersaturated solutions, from which liquid oily precipitates are thrown out periodically, and solidify; the liquid states persists 1.2 seconds in the case of iron or nickel, 15 seconds in the case of cobalt, and 1.80 seconds in the case of copper. Solidification may take place before the liquid has reached a state of equilibrium; this is least likely to occur if the surface-tension of the liquid is high and the viscosity low.

Similar liquid precipitates are formed in solutions of sodium or potassium silicate, with salts of copper, nickel, iron, and manganese, with calcium chloride and ammonia, and with acids, the liquid state persisting 0.3 to 0.5 seconds in the case of iron, 15-20 seconds in the case of manganese, 80 seconds in the case of copper, 120 seconds in the case of cobalt, and indefinitely in the case of hydrochloric acid.

T. M. L.

1575. *Equilibrium in the System Sodium Carbonate, Ethyl Alcohol, and Water.* C. H. Ketner. (Zeitschr. Phys. Chem. 89. pp. 641-690, March 18, 1902. Abstract from Inaugural Dissertation, Leiden, 1901.)—An equilibrium study of the formation of two layers in mixtures of ethyl alcohol and water by the addition of sodium carbonate (compare De Bruyn [see Abstract No. 1122 (1900)], the behaviour of the gaseous-phase (Schreinemakers) [see Abstract No. 1171 (1902)] being also considered.

T. M. L.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

1576. *Steam Engine Governors and Parallel Running of Alternators.* C. F. Guilbert. (Soc. Int. Élect., Bull. 2, pp. 281-327, April, 1902.)—This paper is a *résumé* of the conclusions arrived at by a commission of inquiry appointed to discuss the whole question of the parallel running of alternators as affected by the engine governors (understanding by this term mechanical governors, those worked either wholly or in part by electrical means being outside the scope of the inquiry). Thirteen points were laid down for discussion, each of which is treated separately in this paper. Taking them in order, these points, with the conclusions arrived at, are briefly as follows:—

(1) The desirability of defining by a special coefficient $K = (N_0 - N_{\max})/N_0$ (N_0 and $N_{\max}$ = angular velocities at no load and full load respectively) the controlling power of the governor. This coefficient, or some other similar function of the speeds, has been called the *coefficient of isochronism*. Inasmuch, however, as isochronism is a most undesirable condition for parallel running, the term is inappropriate, and "governor coefficient" is proposed as a better name. The curve representing mean angular speeds as a function of the load is of great importance; this is really the mean between two nearly parallel curves, the difference of whose ordinates is called the *stability*; the actual mean speed for any load may oscillate between the two limits, this oscillation being due, amongst other things, to variations in friction and to play in bearings and gear-teeth. For a given load the "stability" of the governor ought, for reasons which are explained, to be greater than the difference between the maximum and minimum instantaneous speeds during one revolution. This point is discussed, and it is shown that, for the same stability, the loads taken by different sets (supposed of equal capacity) will tend towards equality as the curves referred to are more inclined towards the axis of load. (2) and (3). Various engine-makers and central station engineers were asked to obtain experimentally curves of mean engine speed as a function of load, some of which are reproduced. Pressure in the steam chests, in one typical case, was maintained constant by means of the throttle valve; the curve is nearly a straight line, slightly convex to the origin. The drop is about 5 per cent. between no load and full, the load being that between the alternator terminals. If i.h.p. is plotted as abscissa, the convexity is increased. It is desirable, but not absolutely necessary, that the drop in speed should be proportional to the load; the possible difference in the load taken by two identical sets in parallel is then constant for all loads. The form of curve giving a difference of load *proportional* to the load is that which is convex to the origin; curves with a point of inflexion and a tangent nearly horizontal are quite impossible for satisfactory parallel running. (4) and (5) The necessity for a considerable "governor coefficient" for parallel working necessitates a special compensation arrangement to maintain the frequency constant. Three such devices are described. One consists of a weight movable either by hand or from the switchboard by means of a small electromotor, which varies the effort which the governor must exert in order to come into action; or the effect of the weight

may be altered without the necessity for displacing it, by means of the current in a solenoid. The second way is to act on the admission valve of the engine so as to vary the pressure at the steam ports as the load varies. The third method is to use some automatic regulator, such as the Denis compensator, employed by some engine-builders in Paris. The two first methods, while giving the necessary variation of speed, are not always sufficient to maintain it constant; in such a case, a method devised by Picou has been used, by which a bye-pass with an easily regulated valve is used to shunt the steam admitted to a cylinder. (6) *What is the best type of governor?* Theoretically any form of governor can give a required percentage drop, but practical considerations of dimensions may make one system preferable to another. Quick-acting governors, in which centrifugal force is counterbalanced by springs, are best for parallel running; the possibility of modifying the range, &c., when in place is also an important consideration, and spring governors or those which make use of an inclined plane lend themselves easily to this. (7) *Governor oscillations.* The period of these ought not to coincide with the period of oscillation of the flywheel, if dangerous hunting is to be avoided. With spring governors the period is generally very short, and can easily be calculated. (8) *Method of damping oscillations.* Short-period oscillations, such as, e.g., those depending solely on the governor, can be damped by a dashpot; the damping need not be considerable, as friction alone will do nearly all that is required. Long-period oscillations require very powerful damping; but here a curious effect comes in, that if the orifices in the dashpot piston are adjusted to give the best effect for oscillations of long period, the resulting damping for short-period oscillations will be exaggerated. A remedy for this is to have a dashpot provided with valves which relieve the pressure of the oil when this exceeds a certain limit. [For a description of this device see Abstract No. 1175 (1900).] (9) Governors ought to be of short-period of oscillation, and, to avoid resonance, the various oscillation periods of the plant ought to be different. (10) *The influence of multiple expansion on governor oscillations.* When, as is generally the case, the governor controls the admission to the high-pressure cylinder only, its rapidity of action is diminished by multiple expansion—a condition prejudicial to good parallel working; and the tendency to oscillations is also increased. When the governor acts on the different cylinders, this tendency is less marked. (11) *Oscillations of long period.* These are given rise to by variation in the existing torque under certain states of load and by somewhat undefined conditions of the governor, particularly excessive damping. In the case of two alternators in parallel, they can be produced by a want of balance of power between the two machines owing to lack of simultaneity in the action of the governors. Long-period oscillations can be reduced (1) by increasing the "governor coefficient," (2) by reducing the distance between the two limiting curves which represent mean speed as a function of load, and (3) by increasing the power of the governor. If the alternator drives the engine, however, these oscillations may reappear. (12) and (13) deal with the best way of governing several alternators running in parallel. Should each set have its own governor, as is the usual practice, or would it be better to regulate the speed of the whole system by a single governor (a) acting either on one only of the engines, the governors of the others only serving in case of accident, or (b) acting simultaneously on the admission of all the engines? The first method (each plant separately governed) demands that the governors should be very sensitive and should have practically the same percentage drop at full load; but in practice it is found possible even with

different types of governor to obtain satisfactory results. The disadvantage of this method is that the load comes on or off all the machines simultaneously. **Rateau** proposes to use governors with large percentage drop in combination with Denis compensators; these would be adjusted for the different machines to speeds varying slightly the one from the other. Thus, in the case of four machines running at a speed of about 100, the compensators might be set at 102, 101, 100, and 99 revolutions respectively. Thus there would never under normal conditions be more than one machine running at reduced load; the others would be either fully loaded, or would be taking no load and would of course then be shut down. The second solution (one governor controlling the whole of the alternators running in parallel by regulating the admission of its own engine) may do well enough where the variation is small, as on lighting circuits. Where, however, the variations might exceed the capacity of the controlling machine, serious dangers might be introduced. Against this there is the great advantage that all the other sets are acting under the best conditions economically. With asynchronous alternators this method would be the natural one to employ, if the control were effected by a synchronous alternator. The third method, while electrically leaving little to be desired, is mechanically very difficult to realise. [The memoirs or notes on which this report has been based are appended to the report. They are written by **Blondel, Rateau, Miet, Guilbert, Van der Stegen, Picou, Vigreux** and **Brillié**, and **Chevrier**, and the thirteen points enumerated in the report are discussed at some length.]

B. P. S.

1577. Lubrication and Formation of Bearing Surfaces. J. Dewrance. (Mech. Eng. 9. pp. 378-382, March 22, 1902.)—The film of oil between a shaft and its bearing is under a pressure corresponding to the load on the bearing and is drawn in against that pressure by the shaft forming what may be regarded as an adhesive pump; it does not seem possible that the velocity of the oil and its adhesion to the shaft can produce a sufficient pressure per sq. in. to support a heavy load, but the fact may be verified by drilling a hole in the bearing and attaching a pressure gauge; in some experiments by the author a pressure of over 2,000 lbs. per sq. in. has been realised in this way. The author gives diagrams of various forms of bearings; for slide blocks he recommends that the surfaces should not have channels cut in them, but that each end of the block should be slightly eased so as to form an inclined plane. In addition to the ordinary rule that the oil to a bearing should be supplied at places where the load is not supported, and that beyond such places the surface of the bearing should gradually incline towards the shaft, the author states that there should be no holes or channels by which the oil may escape from between the surfaces where the load is supported. After a description of the casting of white metal bearings, the author gives the following method of preparing the surface as an alternative to scraping: The bearing is put together and bored out 0.01 in. smaller than the shaft; a mandrel slightly taper at one end and true size at the other is then forced through by means of a hydraulic press; it only remains to form the slightly inclined planes by means of a scraper. The bearing produced is stated to have a surface like a mirror and to be superior to anything that can be produced by careful scraping.

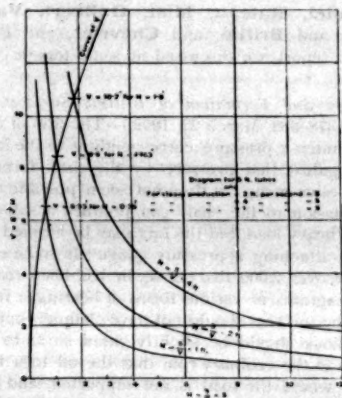
H. R. C.

1578. Relative Positions of Feed and Check Valves, &c. W. Kavanagh. (Power, N.Y. 22. pp. 17-18, May, 1902.)—Some practical considerations are advanced to show that there should be a feed valve on both sides of the

check valve, to facilitate examination and adjustment of the latter. The author also concludes, from reasoning and experiment, that it is better to have the pressure acting above valve discs than under them. F. J. R.

1579. Circulation in Water-tube Boilers. W. H. Booth. (Elect. Rev. 50, pp. 539-541, April 4, 1902.)—Taking as an example a small tube boiler with nearly vertical tubes averaging 5 ft. in length and $1\frac{1}{4}$ in. inside diameter, evaporating 600 lbs. of water per hour per sq. ft. of grate area, or 18.88 lbs. per superficial foot of tube surface, this is practically equal to 26 lbs. of water per tube per hour, or 0.0072 lb. per second. The water contents of the tube being 2.6 lbs. or 0.0426 cubic ft., the tube will be emptied of $\frac{1}{10}$ of its contents, or $\frac{1}{10}$ in. of its length per second. The volume of the steam formed at 200 lbs. pressure absolute, will be 0.0163 cubic ft. per second, occupying about 23 in. length of tube—so that nearly half the length of tube is filled with steam each second, and must be replaced with water. Moreover, the steam carries up the water in front of it into the steam space.

Taking V as the velocity of flow $= 8\sqrt{H}$; H being the head of water represented by the space occupied by the steam, which latter is represented by S , the author constructs the accompanying diagram, giving three curves



for H representing the production of 1 ft., 2 ft., and 4 ft. per second, length of steam plugs in tube. The theoretical velocity of circulation for each case is given by the intersection of these curves with the curve of velocity. The diagram is for tubes of 5 ft. in length, and the evaporation is stated in linear feet of tube occupied by steam per second.

The author estimates the quantity of water, the flow of which should be provided for in such boilers, and shows that the downcomers usually provided are inadequate in area. For flatly inclined or comparatively horizontal tube boilers with larger tubes the case is slightly different, but, taking the Belleville boiler, the author shows the inherent defects in its design from this point of view of water circulation, and considers it "absolutely dangerous and unscientific unless provided with mechanically propelled circulation so certain and positive as to compel a sufficiency of water to pass through the tubes," jointly and severally. F. J. R.

1580. *New Steam Engine Valve-Gears*. **H. Dubbel**. (Zeitschr. Vereines Deutsch. Ing. 45. pp. 1713-1715, Nov. 30, 1901.)—The paper deals with gears for large horizontal engines. A so-called semi-positive Corliss gear is described, in which the variable cut-off arrangement is novel. Only one eccentric is employed, but the admission valves have superimposed on the motion derived in the usual manner from the eccentric, a motion derived from half-way down the eccentric rod and transmitted through a link-motion controlled by the governor. A positive Corliss on somewhat similar lines has the admission valves driven off a subsidiary eccentric mounted half-way down the main eccentric rod. The position of the sheaf of the subsidiary eccentric is controlled by the governor by means of a slot gear, in a similar manner to the ordinary shaft-governor method. A piston type of drop valve, with small clearance in the ports, &c., is described. This motion is sliding, not bedding, thus avoiding the necessity of dashpots.

R. C. R.

1581. *The Scott-Elliot Furnace Equipment*. (Engineering, 73. pp. 484-485, April 11, 1902.)—A horizontal tube which is doubled back upon itself to form a flat spiral is embedded in the brick lining or walls of the furnace, generally on both sides and end. Steam from an injector carrying a small quantity of oil is passed into the lowest tier of the tube spiral, and issues from a number of nozzles or jets in the topmost tier—the jets being directed over the fire surface. It is supposed that the tube spiral becomes red-hot, and that dissociation of the steam takes place, the oxygen then combining with carbon from the oil, as the tube showed no signs of being attacked by the oxygen.

Trials on a Lancashire boiler showed a net gain in efficiency of boiler of from 15 to 21 per cent., and in the case of a Babcock-Wilcox boiler a gain of about 11 per cent., both being cases in which the normal efficiency of the boiler was high. The quantity of oil used per hour in the apparatus was only 1.97 lb. in one instance and 0.8 lb. in another, and under half a gallon in the Babcock-Wilcox case—the steam used in the same apparatus being 110 and 71 lbs. It was noticed that the flame carried farther over the boiler surfaces when the Scott-Elliot apparatus was used, which no doubt ensured an increased rate of evaporation from the boiler surfaces.

F. J. R.

1582. *Fuel Value of Residuals*. **C. F. Prichard**. (Power, N.Y. 22. pp. 23-27, May, 1902. Written for the 29th Annual Meeting of the American Gas Light Association.)—The author takes for a standard an American bituminous coal having a heat value (calculated from ultimate analysis) of 14,885 B.Th.U., a theoretical evaporative value of 14.8 lbs. water from and at 212° F., and a commercial value of \$3.75 per ton of 2,000 lbs., and compares with it, by analysis and tests, gas coke, coke breeze, coal-gas tar, and water-gas tar, in order to find their relative market values as fuel. These he sums up as follows: Coke per ton, \$3.75; breeze per ton, \$2.48; coal-gas tar per barrel of 50 gallons, \$1.88; water-gas tar per barrel of 50 gallons, \$1.39.

F. J. R.

1583. *Flash Steam Generators*. **C. F. Ruby**. (Horseless Age, 9. pp. 409-410, April 2, and p. 438, April 9, 1902.)—The superiority of flash boilers for use on steam automobiles is maintained by the writer. He states that iron, or its alloys, is the best material to use, and he gives his reasons for making the statement; the decrease in strength of copper or aluminium under the influence of heat render these otherwise more suitable metals useless for the purpose. He then goes on to say that tubes must ultimately give way to

specially constructed "flasher sections," in which the heat can pass within the metal at a sufficiently rapid rate to equalise their temperature throughout. Various methods of feeding water to these generators are mentioned, including two systems utilising compressed air. The author seems to favour the employment of granulated metal inside the generator, and mentions brazing spelter as having been used. The question of automatic regulation of temperature is then considered, and four possible means are set forth; that of fitting a device in the hottest part of the generator in such a manner that the fuel feed to the burner is reduced as the temperature increases is evidently most favoured.

A. G. N.

GAS AND OIL ENGINES.

1584. *Explosion Engines*. A. Weber - Sahli. (Zeitschr. Vereines Deutsch. Ing. 45. pp. 1571-1572, Nov. 2, 1901.)—The author describes a method of plotting results of tests, which is only applicable to hit-and-miss governed engines for which $\text{h.p.} = \text{const.} \times \text{pull at brake} \times \text{r.p.m.}$ Taking the last two factors as abscissæ and ordinates respectively, an hyperbola corresponding to any given h.p. can be plotted. If, on the chart thus obtained, observed values of "pull" and r.p.m. are plotted, the h.p. corresponding to any "pull" or load on the brake can be accurately estimated. By further plotting the relation of the number of explosions to the brake pull, it is noticed that the early part of this curve is quite straight, and by producing this part backwards we can deduce the power that must be given to the motor for zero explosions—in other words, the friction loss. Then, assuming the friction loss constant at all loads, a h.p.-efficiency curve is easily deduced. Curves from a 2-h.p. gas engine are given, and the steep nature of the efficiency curve emphasises the desirability of always running explosion engines at their highest b.h.p.

R. C. R.

1585. *Tests of a Riché Gas Producer*. G. Briand. (Génie Civil, 40. pp. 397-398, April 12, 1902.)—Tests on a 10-h.p. engine gave the following figures:—

Fuel.	Sawdust and Shavings.	Sawdust and Shavings.	Sawdust and Shavings.	Belgian Anthracite.	Alrique Anthracite.	Logs of wood 60 per cent. moisture.	Coke.
Mean h.p.	8.84	9.4	9.0	9.0	10.0	10	9.0
Gas per h.p.-hour c.cm.	2.73	2.14	2.32	2.3	2.485	2.73	3.51
Fuel per h.p.-hour kg.	2.07	1.66	1.882	0.547	0.66	2.936	0.737
Mean Calories per c.cm. of gas...	—	—	—	—	1220	1180	950

The author considers that coarse coal will prove the most economical fuel for gas producers. [See also Abstract No. 1908 (1900).]

E. H. C.-H.

1586. *Inverted Combustion Producers of Fangé*. J. Deschamps. (Génie Civil, 89. pp. 323-324, Sept. 14, 1901.)—A description of a producer suitable for reducing wood to gaseous fuel. The charges of wood are put in at the top of the producer, and the air is forced through the glowing mass from top to bottom. The highest temperature is at the top of the producer, and the gas and cinders leave at the zone of lowest temperature. The cinders are

removed by means of a water-sealed trough. The author considers 2·5-3 kg. of wood as calorifically equivalent to 1 kg. of oil. On a plant feeding two 50-h.p. engines the consumption is 2 kg. of wood per h.p.-hour. The calorific value of the gas is given as 1,050 to 1,080 calories per c.cm. at 15° C. for damp wood; 1,220 to 1,270 for dry wood, while by specially adjusting the feed to increase the proportion of methane, this may be increased to from 1,440 to 1,810. [See also preceding Abstract.] E. H. C.-H.

1587. *Producer Gas and its Use in Engineering.* F. J. Rowan. (Inst. Engin. and Shipbuilders, Trans. 45. pp. 27-45, March, 1902.)—The author avoids the usual confusion of applying names to the various gases by including them all under the term "producer," and points out that they vary comparatively little in composition. The objection against producers that heat is lost in combustion is founded on the false theory that all the carbon present is capable of yielding its full amount of heat when converted into CO₂. An example based on L. Bell's analysis is given to illustrate this. In order to utilise the heat derived from cooling the gas, a chemical reaction with steam is brought about, $\frac{1}{2}$ lb. of steam per lb. of coal being the average quantity required. Producers are divided into two classes: (1) Those which send the blast among the fuel in a lateral direction, such as Dowson, Mond, Wilson, &c.; (2) those which introduce the blast vertically, such as the Duff. The blowing area in a Duff grate is given as 1,720 sq. in. as against 160 sq. in. in a similar Wilson producer, thus ensuring a high degree of combustion. Various bases of efficiency are touched upon. The Duff producer shows an efficiency of 81 per cent. on D. Clerk's basis (Min. Proc. Inst. C.E. vol. lxxxiv.), which states that with pure carbon and air alone a perfect producer would give a mixture of 1 vol. CO and 2 vols. N, leaving at a high temperature. After emphasising the wastefulness of the ordinary furnace, the author considers various applications of producer gas. (1) In steel making, iron puddling, welding, and processes requiring a high temperature, producer gas has won its greatest triumphs. Drawings of suitable producers are given. (2) For reheating iron, forging, &c., the Weardale furnace is very suitable, $1\frac{1}{2}$ to $2\frac{1}{4}$ cwt. of coal being required per ton of iron heated. In (3) a usual form of foundry stove is illustrated, and (4) deals with gas-fired boilers, an average of 9·29 lbs. of water evaporated per lb. of coal being obtained. (5) and (6) describe the application of gas to brick kilns and gas retorts. Under the heading Power the following figures occur: "The heating power of producer gas is within the range 144 to 190 B.Th.U. per cubic foot," and "the cost of production, using expensive coal, is about 1d. per 1,000 cubic feet, and using slack, about $\frac{1}{2}$ d."

Discussion.—P. N. Cunningham had used the commonest dross with good results. C. G. Norris gave the following figures for heating plates:—

	Ordinary Coal-fired Furnace.	Weardale Gas-fired Furnace.
Size of Furnace	15' 6" x 6'10"	14' 10" x 5' 6"
Lot of plates heated 58 hours	17 tons.	45 tons.
Cost of heating per ton of plates...	4s. 5d.	2s. 2d.

J. F. Maclaren had been using anthracite and coke for producers, and experienced trouble with clinker, and with tar clogging the gas-engine valves. A. Wilson considered coke from the south easier to deal with on account of its higher quality. Clinkering was increased if the gas had to be transmitted to a distance necessitating higher pressure. Producers could be shut down

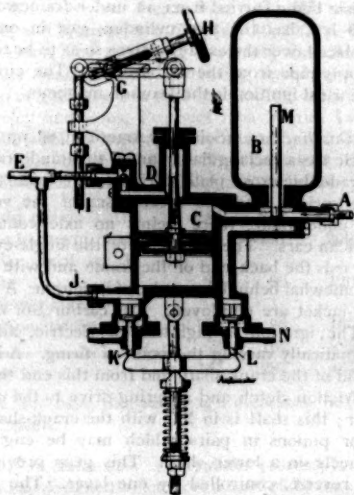
for a day or so. **The President** described an automatic gas-producing regulator. Such regulation is much easier with coke than with bituminous coal. **The Author**, in reply, explained the relation between the heat values of C and CO. The advent of possible coal famines put producers in a more favourable position than formerly. He did not understand Maclaren's trouble with tar. **J. F. Maclaren** explained that he had used Scotch anthracite, and had found that tar arising from coke was worse than that from anthracite. [See also Abstracts Nos. 1173 and 1567 (1901).] R. C. R.

1588. *The Diesel Oil Engine*. (Frank. Inst., Journ. 152, pp. 871-882, Nov., 1901.)—This is a report of a Committee of the Institute. After a careful theoretical consideration of several possible cycles, Diesel concluded that the Carnot cycle (of two isothermal and two adiabatic curves) was the most efficient, and his motor is designed to approximate as nearly as possible to it. He gives four conditions for high economy: (1) The combustion temperature must be obtained, not by combustion but by previous compression; (2) this is best accomplished by combining the isothermal and adiabatic compression stages of the Carnot cycle into one adiabatic compression stage; (3) the fuel should be introduced gradually and burned without rise of temperature; (4) a considerable surplus of air should be present. The motor is of the marine engine type. On one down-stroke the main cylinder is filled with air, which on the up-stroke is compressed adiabatically to 35 atmospheres. At the beginning of the following down-stroke, by means of an auxiliary air-jet, working at about 40 atmospheres, petroleum is injected into and ignited by the red-hot air in the cylinder, the duration of inlet and combustion being regulated by means of a bye-pass valve controlled by the governor. The combustion and expansion take place isothermally. The exhaust is said to show no trace of oil. The results of tests show an effective (b.h.p.) thermal efficiency of—(1) 25.7 per cent. at full and 22.4 per cent. at half load (Schröder), and (2) 25.06 at full and 19.09 at half load (Denton on a 20-h.p. motor). The (i.h.p.) thermal efficiency of an ordinary Otto cycle gas engine is set at 17 to 22 per cent., and of a combined boiler and steam engine at 12 per cent., these figures being subject to reduction for b.h.p. efficiency. The Committee make special comment on the combination of theory and practice embodied in the design of the motor, and on the close approximation of the actual indicator diagrams to the predetermined theoretical diagrams upon which the design was based. An internal combustion motor should have the following features realised in its action: (1) There should be very complete subdivision of the combustible, and thorough mixture with the air; (2) the combustion air should be raised to a high temperature; (3) previous vaporisation of the combustible should be avoided, and there should be no separation of light and heavy constituents; (4) the combustible should not come in contact with cold walls of the cylinders; (5) there should be no previous mixture of the combustible with more or less cold air; (6) combustion should be independent of the velocity of propagation of flame; (7) the pressure should be raised as high as possible before combustion. The extent to which these theoretical features have been attained in the Diesel motor are then enumerated.

On the strength of this report Herr Diesel was awarded the Elliott-Cresson medal. [See also Abstract No. 940 (1901).] R. C. R.

AUTOMOBILISM.¹

1589. *Creek Street Company's Light Steam Van.* (Automotor Journal, 7, pp. 53-54, April 26, 1902.)—A light steam van by the Creek Street Company of Deptford has a paraffin heated coil boiler. The three-cylinder vertical engine with cam operated valves drives a pair of force pumps, one for water and one for paraffin. The supply of paraffin is regulated by the boiler pressure. The diagram shows the action of the regulator. Water enters the pipe A. The pressure of the feed-water is kept constant on the upper side of the piston and in the air chamber B by means of the spring holding the valve L on its seat, the feed-pump delivering slightly more than the maximum quantity at any time required. This pressure remains constant, in consequence of the valve L being held on its seat by the spring shown, the valve



allowing any water to flow back to the tank if the pressure rises above the normal. The pressure in the chamber C forces the piston downwards, and at the same time keeps open the orifice between the piston rod F and the rod D. This downward action causes the burner to open wider by the upward action of the rod A. If the boiler pressure rises above a certain point it operates upon the lower side of the piston, forcing it upwards, thus cutting off the burner and ultimately closing the free passage of water through D. If the boiler pressure rises considerably it opens the valve K, which is normally held on its seat by the same spring which holds the valve L, and the water in the boiler is allowed to run out. By this means the position of the piston in the chamber C depends upon the pressure in the boiler. The relative heat of the burner to the quantity of water fed into the boiler is regulatable by the handle wheel H.

M. O'G.

¹ Electric Automobiles are described in the Section dealing with Electric Traction.

1590. *Lehmbeck Spirit Motor Ploughing Locomotive*. (Motorwagen, 5. pp. 96-97, March 31, 1902.)—This vehicle is designed for travelling over heavy ground with loaded trailers. The wheels are of the well-known road locomotive type, the driving wheels, which are situated at the rear of the vehicle, being shod with iron cross-bars. The motor is arranged at the front of the vehicle, with its shaft along the axis, and transmits power through double bevel and spur wheels to a counter-shaft, which is geared to the rear axle through chains. The motor shaft projects in front of the vehicle, and is fitted with a pulley, from which power is taken for driving a plough. The water tank is situated directly above the rear axle, so as to increase the adhesion of the driving wheels. J. G.

1591. *The Brush Petrol Car*. (Automotor Journal, 7. pp. 37-39, April 26, 1902.)—The Brush car is built on a main rectangular framework of wood and steel, the mechanism being carried from an under framework. The Abeille type motor of 10 h.p. has the two cylinders cast in one piece, and the induction valves placed over the exhaust valves so as to be removable without taking off the supply pipe from the carburettor. The circulating pump is gear-driven. The usual ignition is the Dawson magneto. M. O'G.

1592. *Packard Gasoline Car*. (Scientific American, 86. pp. 146-147, March 1, 1902.)—This vehicle has a rectangular channel steel underframe sprung from the front axle by double-cross plate springs, and from the back axle by elliptic side plate springs, and the mechanism of the vehicle is directly attached to this underframe, there being no axle connecting frame, so common on American cars. The engine is of the single-cylinder horizontal type mounted towards the back end of the frame and with crank-shaft lying across the frame somewhat behind the centre of its length. A cast-iron cylinder and copper water-jacket are employed. The carburettor is of the float-feed spraying type. The ignition is high-tension electric, and the engine is governed by automatically varying the point of firing. A heavy flywheel is mounted at one end of the crank-shaft, and from this end the power is transmitted through a friction clutch and a spring-drive to the upper shaft of the change-speed gear; this shaft is in line with the crank-shaft, and on it are mounted four spur pinions in pairs, which may be engaged with corresponding fixed wheels on a lower shaft. This gear provides three speeds forward and one reverse, controlled by one lever. The power is finally transmitted from the second motion shaft of the change gear to the live rear axle by a single roller chain. Suitable radius rods are provided for maintaining the correct distance for the chain centres. Wheel steering, acting through a worm and sector gear, is employed. C. R. D'E.

1593. *Roller Bearings for Automobiles*. **Hele-Shaw**. (Automobile Club Notes and Notices, 3. pp. 92-96, March, 1902. Paper read before the Automobile Club.)—After some general remarks on the action and advantages of roller bearings, the author summarises as follows the difficulties which are encountered in their design and construction: (1) The concentration of the load on a very small bearing surface; (2) the difficulty and expense of obtaining rollers truly cylindrical and circular; (3) the friction between the rollers themselves; (4) the difficulty of adjustment; (5) the tendency to twisting when worn; (6) the provision for end thrust; (7) the occurrence of hammer blow and shocks, with motor cars, when worn. No. (1) is minimised by efficient hardening, and as this always causes some deformation, subsequent

grinding, an expensive process, is required to obtain the best results. Parallel roller bearings being incapable of adjustment, this difficulty has been met by the use of conical rollers, which may also be so designed as to take up the end thrust which has to be provided for in the case of motor cars. The author describes several methods of caging designed to obviate both (3) and (5). In conclusion he observes that he has not considered the amount of power that may be saved by the use of roller bearings, since their advantages in this respect are undisputed, and the only obstacle to their general introduction is the difficulty of obtaining an efficient form of bearing which can be cheaply constructed. *Discussion.*—**W. Beaumont** believed that it was fairly well established that the advantages of roller bearings diminished with increasing speed, which he ascribed to the friction of the rollers in the guides.

G. W. DE T.

1594. Roller Bearings for Automobiles. G. W. de Tunzelmann. (Automobile Notes and Notices, 3. p. 278, July 10, 1902.)—In confirmation of Beaumont's suggestion [see preceding Abstract] that the falling-off in the advantage of roller bearings with increasing speed is mainly due to the increased friction of the rollers in their guides, the author quotes tests made by Messrs. Whiteley and Sons, Prospect Iron Works, Lockwood, on some bearings with hollow rollers kept apart by internal pins, a method of guiding which minimises this braking effect. The results of the tests made on bearings $1\frac{1}{4}$ in. diameter, and $3\frac{1}{4}$ in. long, are as follows:—

Total weight put on.....	245	848	1,468	2,852 lbs.
Weight per in. run of bearing...	35	121	209	836 „
Weight per axial sq. in. of bearing	20	69	120	192 „
Speed and power taken:—				
175 revolutions per minute.....	62	96	160	300 watts
280 „ „	75	162	225	450 „
570 „ „	141	287	481	— „

Showing that, in this case, the advantage increases, instead of decreasing, with increasing speed.

M. O'G.

1595. Simms War Motor Car. (Automotor Journal, 7. pp. 15–16, April 19, 1902.)—This is a car designed to support a load of 12 tons, having an overall frame dimension of 17 ft. $\times$ 6 ft. 2 in. The 12-h.p. motor of Carnstatt-Daimler type drives the car at $1\frac{1}{2}$, 3, 5, or 9 miles an hour. The weight of the car itself is $5\frac{1}{4}$ tons, the armature is 6 mm. Vicars steel, and its length from point to point of the rams is 28 ft. Its width is 8 ft. and height 10 ft. The armature swings independently of the frame. The gun equipment consists of two pompoms and two quick-firing maxims, with 10,000 rounds of ammunition. Plans and sections of the car are given.

M. O'G.

1596. Determination of the Path of Air-Ships. H. Deslandres. (Comptes Rendus, 134. pp. 344–346, Feb. 10, 1902.)—The author criticises the method of Armengaud as inaccurate, and favours the determination by means of photographs. A camera is used in conjunction with a chronometer, which automatically registers the exact moment at which an exposure is made. To facilitate calculations, two consecutive images may be taken on the same plate. Diagrams of the path of Santos-Dumont's air-ship, as traced by the author, are given. [See also Abstracts Nos. 891 and 551 (1902).] E. H. C.-H.

GENERAL ELECTRICAL ENGINEERING.

1597. *Insulation of Electric Supply Cables.* P. Charpentier. (Soc. Int. Élect., Bull. 2, pp. 204-234, March, 1902.)—The high-insulation resistance usually required of cable-makers is not in itself of much value; even if the resistance were reduced to one-thousandth of its usual value, the loss of energy by leakage would be negligible. These high insulations are demanded merely as a guarantee of the quality of the cable, but they should not enter into the specification of a cable, for an insulation of equal durability and equal strength against rupture might have far less resistance and be equally serviceable in practice. The insulation of a cable should satisfy the three conditions of (1) a definite maximum leakage, (2) strength against rupture, and (3) durability. As a measure of the resistance should be taken that observed when the current has become practically constant, not that after one minute's electrification. The ratio of these two resistances varies largely in different sizes of cables, and for continuous currents the former only has any practical value. The strength against rupture bears very little relation to the insulation resistance. It depends really on the uniformity of the materials used and the care exercised in manufacture, for over a small surface, the thickness of insulation for a given strength is often only about one-tenth that required in a long cable. It is not advisable to test the whole cable, as is usually done, at a pressure double the working pressure, as such a test may permanently injure the insulation. The better test is to measure the pressure of rupture over a length of the cable and allow a factor of safety of 4 to 5. The author suggests that cables could be cheapened by substituting for the armouring, lead sheathing, and for a dielectric of high-insulation resistance, a thick layer of moderately insulating material sufficiently strong to withstand handling and laying, which could be applied to the bare copper as the cable was laid. G. H. B.

1598. *Cable Deterioration.* C. Formenti. (Elettricista, Rome, 11, pp. 99-100, April, 1902.)—The author observed the deterioration of the return wire of an earth cable composed of twenty strands of galvanised electrolytic copper wire, covered first with cotton and then with a composite rubber coating. Soon after the cable was put down small vesicles of liquid appeared in the rubber coating, and these increased in size till they burst. By analysis of the rubber and also of the contents of the vesicles, it was shown that the rubber envelope, and not the soil, furnished the materials for the contents of the liquid. By heating up the rubber with water a quite similar solution to that of the vesicles was obtained. It appears, therefore, that the rubber coating acted as a semi-permeable membrane, and admitted water, which dissolved out part of the contents of the rubber. The current then set up electrolysis in the solution so obtained. The deterioration described was prevented by coating the cable with a non-permeable substance such as coal-tar. D. H. J.

1599. *Cranes in German Dockyards.* (Engineer, 93, pp. 410, 414, and 418, April 25, 1902.)—This article contains a description and drawing showing the general construction of various dockyard cranes, made by the Benrather Machine Company. The latest and largest of these has been constructed for the Howaldtswerke at Kiel, and lifts a working load of 150 tons at a

radius of 65 ft., and of 50 tons at a radius of 184 ft., the gantry rails being 154 ft. above the level of the ground. It is worked by three-phase induction motors. It is very similar in outline to the one built by the same firm in 1889 for the dockyard at Bremerhaven, which is worked by direct-current motors. The principal outlines of the design in both these cranes are fully described.

W. H. S.

1600. *Electric Pumping Plant.* (Engineer, 93. p. 355, April 11, 1902.)—This plant, which is said to be the largest of its kind in this country, has been put down by Scott and Mountain at the Eldon Colliery, Durham. The generating plant consists of a 220-kw. steam-driven dynamo, supplying current at 500 volts to motors at the bottom of a shaft, 150 yards deep. The motors drive the pumps by cotton ropes; the motor speed is 450 r.p.m.; the pump speed 27 r.p.m., and each pump delivers 500 gallons per minute against a head of about 400 ft. On test the following figures were obtained on full load. The pumps delivered 64·8 gallons of water against a head of 400 ft. per lb. of coal used in the boilers. The ratio between the output at the dynamo terminals and the h.p. in the water pumped, the pumps being at a distance of 1,000 yards from the generator, was 72·7 per cent. The efficiency of the pumps alone was found to be 85 per cent., and of the motors 91 per cent.

W. H. S.

REFERENCES.

1601. *Calculation of the Capacity of Accumulators at varying Discharge Rates.* J. Izart. (Ind. Elect. 11. pp. 153-154, April 10, 1902.)—The paper describes a graphic method, and is illustrated with curves. E. J. W.

1602. *Electric Storage Batteries.* A. Reuter Dahl. (Cassier, 21. pp. 489-502, April, 1902.)

1603. *Electric Foundry Cranes.* A. Krebs. (Elekt. Runds. 19. pp. 129-130, March 15, 1902.)—The article contains sketches of different types of crane and lifting tackle, employed in foundry work, and operated electrically. W. H. S.

1604. *Coal-cutting by Machinery.* E. K. Scott. (Inst. Civil Engin., Proc. 144. pp. 247-268, 1901.)—A record with descriptive woodcuts of the various types of percussive, wheel, and rotary bar coal-cutters that have been put in use with the results of their working. The paper contains too much detail to be abstracted.

LL. B. A.

1605. *Electricity in Mountain Mines.* F. W. Brady. (Amer. Inst. Elect. Engin., Trans. 18. pp. 281-291; Discussion, pp. 402-406, 1901.)—The author describes plant installed in the mountains of California and Colorado, with special reference to methods of constructing plant so that the parts could be brought into place by mule or human transport.

LL. B. A.

1606. *Use of Electricity in Belgian Coal-mines.* Halleux. (Soc. Belge. Élect., Bull. 18. pp. 269-277; Discussion, pp. 277-280, 1901.)—The author describes the present position of the use of electricity in the coal-mines of Belgium. About 3,000 h.p. is now so transmitted in Belgium. The paper is chiefly interesting in so far as it expresses generally the attitude of Belgian engineers towards electrical work in its various branches.

LL. B. A.

GENERATORS, MOTORS, AND TRANSFORMERS.

1607. *Magnetic Reaction of Dynamo Armatures.* V. Karpen. (Comptes Rendus, 184. pp. 827-829, April 14, 1902.)—The author points out that in calculating the magnetic reaction of the armature it must be remembered that the reluctance is greater in the direction of the pre-existing flux than in the opposite direction. The transverse ampere turns have a maximum effect near the bend of the curve of magnetisation of the pole-pieces and armature. Magnetic leakage diminishes the useful flux and increases the demagnetising flux. He gives a table of experimental results to show that the demagnetising effect of the armature has a maximum for a certain value of the excitation.

R. B. R.

1608. *Armature Winding Diagrams.* D. Robertson. (Inst. Elect. Engin., Journ. 81. pp. 949-970, April, 1902.)—The author shows how to construct winding tables, circuit tables, and current diagrams for a number of different windings. The current diagrams are particularly useful in studying the changes in the distribution of the current during commutation or with different widths or arrangements of brushes.

R. B. R.

1609. *Commutation.* Boy de la Tour. (Ind. Élect. 11. pp. 79-88, Feb. 25; and pp. 107-112, March 10, 1902.)—The author of this paper considers that the usual method of attacking the problem of commutation is unfortunate; the introduction of the term $L di/dt$ really complicates the question quite unnecessarily. Starting from elementary considerations, and taking first the case in which the brush only presses on two commutator bars simultaneously, it is shown that the self-induction of the coils short-circuited by the brushes is practically negligible, and that these coils move in a constant field, and are therefore the seat of an invariable electro-motive force. This granted, equations are deduced which give the value of the current at each instant, and the condition for sparkless running is found to be $R_i i_1 \geq e + I(R_a + 2R + 2R_{II})$ where R_i , R_{II} are the contact resistances of the brushes on the two commutator bars (the former being that of the leading bar); i_1 is the current passing between the brush and the leading bar at the moment of commutation; R_a is the ohmic resistance of the short-circuited coil; I is one-half of the normal current of the machine, e the e.m.f. generated in the coil, R the resistance of the connection between the winding and each commutator bar. The e.m.f. $i_1 R_i$ is the limiting tension which will admit of good sparkless running. The equation shows that, keeping the output the same, reduction of the speed by diminishing the value of e lessens the sparking, a deduction which is supported by experience; it also shows the importance of keeping the term $R_a + 2R + 2R_{II}$ as small as possible, i.e., of reducing the resistance of the connections between the commutator bars and the windings. It is suggested that absolutely sparkless commutation might be obtained without shifting the brushes if small auxiliary poles were provided close to the latter, these poles being excited in series with the armature; the e.m.f. e could thus be annulled for any value of the current. The case is then discussed in which the brushes press upon three commutator bars at the same time, i.e., the width of the brush exceeds that of bar plus insulation, and a similar equation is arrived at

as the condition for sparkless running. The permissible limit for iR is given as about 2.5 volts. The latter part of the paper is taken up with a discussion of the general question of sparkless commutation, in which it is shown how all the phenomena observed can be explained by means of the equations; and it is further shown how, in the case of a machine which sparks excessively, the true cause may be assigned. By means of an exploring coil the strength of the field in which the short-circuited coils are moving can be measured, and the equations given can then be made use of to determine whether the values of the tension between the brushes and the commutator bars are satisfactory. If the values found are not excessive the fault is not strictly one of commutation, but lies either in the condition of the commutator, the action of the brush-holders, or the design of the winding. The paper concludes with two numerical examples worked out at length. The article is illustrated by diagrams and curves.

B. P. S.

1610. *Self-exciting Alternators*. M. Latour. (Écl. Électr. 81. pp. 50-59, April 12, 1902.)—This paper contains a detailed account of the theory of the author's self-exciting alternator [see Abstracts Nos. 384, 1235, and 1440 (1902)]. In many respects such an alternator closely resembles an ordinary continuous-current shunt-wound machine. In order to secure synchronous running, the brushes through which the three-phase currents are fed into the high-resistance rotor winding must be given a forward lead, which has to be increased with increasing load. On account of the high resistance of the rotor or field winding, and the consequently small current in this winding, there are no difficulties as regards commutation. When a sudden increase of load takes place the machine drops slightly out of synchronism, and the slip of the rotor reduces the drop which would otherwise take place in the p.d.; by readjusting the brushes synchronism may again be established. The concluding part of the paper is of a controversial nature; the author points out that a self-exciting shunt-wound alternator such as the one described by himself has nothing in common with a form of motor devised about 1890 by Rotten, several examples of which were constructed by Siemens and Halske. In Rotten's motor three-phase currents were fed into the three-phase winding of the stator, and into the continuous-current armature winding of the rotor, which was provided with a commutator and brushes. Each winding gave rise to a rotating field, and the torque was due to the non-coincidence of the fields. By shifting the brushes the stator field could be arranged to be either behind or in advance of the rotor field, and so the motor could be made to run either way; further, the motor could be made to run at varying speeds independently of the frequency of supply—it was essentially an *asynchronous* motor. The thickness of the wire used in the rotor winding was, in Rotten's motor, of the same order as that of the stator winding. In contrast to this arrangement, the author points out that in his own machine the rotor will always start in the direction of the rotating field, no matter what the position of the brushes may be, and that the motor does not attain its normal torque until the speed has become nearly synchronous; further, the rotor winding has a very high resistance. The resistances of the rotor windings used in Rotten's motors would have been burnt out at synchronous speed.

A. H.

1611. *Synchronous Reactance*. F. G. Baum. (Elect. World and Engineer, 39. p. 724, April 26, 1902.)—The author shows, by a graphical method, that the use of "synchronous reactance" instead of demagnetising effect and leakage reactance in predetermining the drop in an alternator does not generally lead

to any appreciable error. He suggests that instead of determining the "synchronous reactance" from the short-circuit current—a method which generally gives a larger value than that corresponding to a fully excited field—this quantity might be obtained by running the alternator as a synchronous motor, and gradually increasing its excitation until a current of about the same order as at full load is obtained through the armature. The difference between the p.d. and the e.m.f. of the motor then practically gives the reactance e.m.f. A. H.

1612. *Parallel Running of Alternators.* P. M. Lincoln. (Frank. Inst., Journ. 158. pp. 241-257, April, 1902.)—In this paper the author discusses the general question of parallel running, which he considers a problem of engine governing pure and simple. Proper division of load depends on the percentage drop of speed between no load and full load; hunting can be reduced by diminishing the motive force, which by synchronising with the pendulum swing may increase the oscillations to a dangerous pitch, and by damping out the oscillations by electrical friction. The first result can be achieved by prolonging the time of response to motion of the governor balls, which can be done by properly designed dashpots [see Abstract No. 1175 (1900)]. The effect of the uneven torque at different points in an engine cycle in causing hunting can be remedied by increasing flywheel power, and by synchronising engines as well as alternators. The damping out of the oscillations can be effected by surrounding the field poles with copper bands, or better, by projecting copper plates under the pole-tips; these are in a better position than the bands round the field poles to generate the necessary eddy currents, as they lie more completely in the resultant field. The paper concludes with a description of the various methods of synchronising in general use, none of which are satisfactory, owing to lack of sensitiveness, and to the fact that no information is given as to which of the two phases which are being compared, is in advance of the other. The author describes a device of his own which is superior in every way to the old methods, and which is a true phase indicator, independent of the two e.m.f.'s whose phase relation it indicates, and showing by the angle between a moving and a fixed pointer on a dial the exact difference of phase, and by the direction of rotation of the moving pointer which e.m.f. is in advance of the other. [See also Abstract No. 1948 (1901).] The device is used by the Niagara Falls Power Company, where by its aid five 5000-h.p. dynamos have been synchronised in three minutes.

B. P. S.

1613. *Parallel Running of Alternators.* H. C. Leake. (Elect. Rev. 50. pp. 548-544, April 4, and pp. 681-682, April 18, 1902.)—In this paper the author deals with the effect of the cyclical speed variation of a prime mover coupled direct to an alternator upon parallel running, and comes to the conclusion that the usual method of specifying a maximum permissible phase displacement, when the plant is run on a load offering a constant torque, is not justified by theory. He contends that the more rational method of designing the rotating parts would be to proportion them so that what he terms the "characteristic fluctuation of output"—i.e., the periodic variation of output as affected by the periodic variation of torque—should not exceed a certain limit. The author also comes to the conclusion that the statement that parallel running is facilitated by low frequency is unwarranted by theory. The amount of phase displacement usually allowed in prime movers is not more than 2° when the load includes rotary converters; for a load of synchronous motors it may be a little more, and for a non-synchronous load

a still larger displacement is allowed. When two alternators giving the same e.m.f. are running in parallel, the method generally adopted to calculate the maximum cross-current is to obtain the resultant e.m.f. tending to produce this current (by multiplying the e.m.f. of either machine into twice the sine of the maximum phase displacement), and to divide the product by twice the synchronous impedance of one armature. The usual assumption, which is controverted by the author, is that if the rotating parts are so designed (as regards inertia, &c.), that the maximum phase displacement is not exceeded when running on a load with constant torque, then in parallel operation the maximum cross-current will not be exceeded. This assumes something which is untrue, viz., that the maximum phase displacement in parallel is no greater than when running singly on a load of constant torque; nor is the phase displacement necessarily reduced by the interchange of power between alternators in parallel. By a graphical method, using curves in which the abscissæ are the phase-differences between the e.m.f. of the alternator in question and that of the bus-bars, and the ordinates are the two components (phasal and wattless) of the alternator current, and the driving torque, the author shows that if the moment of inertia of the rotating parts of a generator set exceeds a certain amount, the actual maximum phase displacement when running in parallel exceeds that when running on a load offering a constant torque. He also shows that there is, for every set, a critical value of the moment of inertia depending on the periodic time of the fluctuation of driving torque, so that the conditions are improved either by reducing or increasing the moment of inertia.

B. P. S.

1614. *Synchronous Motor Calculations.* F. G. Baum. (Elect. World and Engineer, 39, pp. 861-864, May 17, 1902.)—The author gives an account of a simple graphical method of attacking synchronous motor problems which is practically identical with that given by Görges and referred to in Abstract No. 1360 (1900). If in the vector diagram the p.d. across the generator or motor terminals be supposed to remain constant while the excitation of the machine is varied—the power remaining constant—then the extremity of the e.m.f. vector moves along a straight line.

A. H.

1615. *Theory of Asynchronous Motors.* Colard. (Assoc. Ing. Éli. Liège, Bull. 2, pp. 8-19, Jan., 1902.)—This paper contains a mathematical investigation of the general theory of asynchronous motors. The writer imagines a mass of iron of a given thickness, but of indefinite extent in the two other directions, in which a cylindrical hole is pierced, containing a cylinder of iron of slightly smaller diameter. These two masses constitute the stator and rotor respectively. A distribution of currents in sheets on the surfaces of the stator and of the rotor is assumed, whence is deduced (on the assumption that the reluctance of the iron is negligible compared with that of the air-gap), a corresponding distribution of the magnetic flux in the air-gap. Formulae are then found for the electromotive forces and currents developed, and for the resultant torque, and the results are seen to be interpretable by means of Heyland's diagram.

B. P. S.

1616. *Tests of a Multiphase Motor.* E. Ziehl. (Elektrotechn. Zeitschr. 23, pp. 236-239, March 20, 1902.)—The paper describes a series of tests made on a four-pole motor for a normal output of 10 h.p. on a 190 volt 50 $\sim$ three-phase motor, designed by the author for the Schwartzkopf Company. Sections of the motor are given, as well as curves giving efficiency, power-

factor, and slip for different loads, losses when running light at different voltages, and starting torque at different voltages. The efficiency reaches a maximum of 91 per cent. at half load; at full load it is 90 per cent. The power-factor reaches 0.925 with a load of 9.5 h.p. To determine the limiting load on intermittent work for a given temperature limit, a series of time-temperature curves for different loads were taken, as well as cooling curves both running light and standing. From these curves the limiting load under different conditions is determined graphically. Thus while the motor in question could give 14.6 h.p. indefinitely without rising more than 50° C. above the air temperature, if loaded for 20 minutes to 17.5 h.p. it would require to stand for 40 minutes in order to remain below the same limiting temperature.

A. E. L.

1617. Transformer Regulation on Inductive Loads. **P. C. Butte.** (Journal of Electricity, S.F. 12. pp. 99-100, May, 1902.)—A practical formula is given for the p.d. drop across the secondary of a transformer on an inductive load. Experiments were made and curves are shown illustrating the effects of an inductive load on the p.d. between the terminals of the secondaries of a single-phase transformer wound for three-wire distribution. The curious effect was observed that, when one side had an inductive load and the other side was on open circuit, then there was a gradual rise of the p.d. on the unloaded side as the inductive load (power-factor 0.7) was increased. This was probably due to the magnetic leakage from the windings of the loaded secondary.

A. R.

REFERENCES.

1618. Measurement of Armature Resistance. **A. Wettler.** (Elektrotechn. Zeitschr. 23. pp. 8-10, Jan. 2, 1902.)—The paper gives formulæ for the calculation of the armature resistance of multi-polar direct-current generators derived from a knowledge of the type of winding.

W. W. H. G.

1619. Formulæ for Regular Armature Windings. **D. Robertson.** (Inst. Elect. Engin., Journ. 31. pp. 933-948, April, 1902.)—The author works out a number of formulæ for the conditions of re-entrancy, number of re-entrances, and conditions for not clashing, for gramme and drum armatures.

R. B. R.

1620. Induction Motor with Power-factor of Unity. **A. Heyland.** (Écl. Électr. 30. pp. 419-423, March 22, 1902.)—This is a brief exposition of the principles underlying the construction of the author's motor [see Abstract No. 2475 (1901)], and a comparison with the motors devised by Görges, Latour, and Blondel.

A. H.

1621. Tramway Motors. **Siebert.** (Elektrotechn. Zeitschr. 23. pp. 187-190, March 6, 1902.)—A discussion of various points in the design of traction motors, particularly for large powers, where there is difficulty in keeping the dimensions within reasonable limits. The design adopted by the author for the motors of the Maison Breguet of Paris is illustrated by outline drawings and sections.

A. E. L.

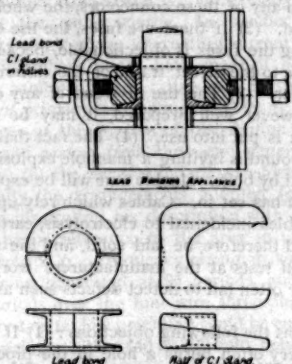
1622. Wagner Single-phase Motors. **E. S. Pillsbury.** (West. Electr. 29. pp. 318-319, Nov. 16, 1901. Abstract of paper read before the Ohio Electric Light Association at Put-in-Bay, Ohio.)—A discussion of the merits of single-phase distribution, in addition to a description with drawing and diagrams of the Wagner single-phase motors. [See also Abstract No. 346 (1900).]

A. E. L.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

1623. *Continuous-Current Mains.* J. C. A. Ward. (Inst. Elect. Engin., Journ. 31. pp. 838-852; Discussion, pp. 852-878, April, 1902.)—Ends of cables in manholes where the conductors terminate in thimbles are often sealed by means of lappings of insulating tapes over the socket and back to the lead covering of the cable, but a creeping current will set up across the tape between the bare socket at the end of the conductor and the metal sheathing. Salts due to electrolysis are deposited on the tape, and will be found to have worked under the layers of the tape. The author recommends doing away with tapes and sealing the cable ends in an end-connection box filled with compound, bringing the bare socket through a gland of insulating material such as ebonite, having a corrugated surface. Efficient bonding between the sheathings of the cables terminating at either side of a box is needed. A



single strand of, say, No. 16 gauge copper wire, although sufficient to guard against electrolysis, is inadequate, because it is fused away when, through defects in insulation, heavy currents have passed along the lead sheathing. The disconnection between sections of lead sheathings thereon resulted in faults at the glands owing to the lead having arced on to the box. A wiped joint between the ferrule of the box and the lead sheathing makes an excellent bond and a watertight joint. Efficient bonding should be carried out irrespective of the intentional earthing of any of the poles of the system, as a complication of faults may lead to heavy currents travelling on the lead between points a considerable distance apart. A joint between lead and box may be made without a wiped joint as shown in the accompanying diagram.

One form of an earth-plate used in Glasgow is a 6-ft. length of unpainted cast-iron 4-in. pipe driven vertically into the earth, and connected,

by means of a special bond, to an "earthing" copper conductor in the section boxes. Feeders and networks should be so fused that faulty circuits will be automatically isolated, because 100 yards or more of main may otherwise be completely destroyed. The difficulty is that, in the event of a fault occurring in a certain locality, current flows to this fault from the several feeding-points through several fuses in series, with the result that, instead of fuses blowing in the neighbourhood of the fault, they may be blown at a considerable distance away, thus throwing dead large sections of distributors, the supply to which should not have been interrupted. The rule to be observed is that not more than two feeders shall be connected directly with the distributors laid between them, the connection between these feeders and any others only being made between their respective feeding-points, and not by means of distributors joined at points of intersection of the network between feeding-points. This arrangement avoids the inconvenience of dividing the network into isolated sections and allows out of balance currents to be rectified throughout the general system of network. There are advantages in cast-iron instead of brick manholes—(i) if the system of mains requires earth plates the cast-iron manhole serves the purpose. (ii) Cast iron is both gas and water proof. (iii) The space saved by using cast iron instead of brick provides more room for the fittings inside the box. In most ordinary boxes—(1) the clearance between conductors of opposite polarity is so small that, if once an arc is started between any of these connectors, the whole of the other cables become short-circuited. (2) If there are fuses, the use of set screws or nuts and studs for securing the fuses is objectionable, because the fuses become slack by vibration due to the street traffic or the different expansion of the fuse and the conductor. (3) The use of wood of any description is objectionable, because, however well prepared, it may be in a damp store for months before the box is put into use. (4) The fact that the fuse is in close proximity to the compound is inviting a manhole explosion if the fuse blows. (5) If the lid is secured by bolts, valuable time will be expended in endeavouring to remove it if rust has set in. Cables which rely upon a lead sheathing suffer most from troubles incidental to electrolysis, earth currents, and bad bonding. They should therefore be laid solid, and the metal sheath should be bonded. The usual tests at the manufacturers' works, before the cable has been certified, very often fail to detect defects such as admission of water or pinholes.

A draw-in system has the following objections: (1) If the ducts consist of metal pipes, a fault very often burns a hole in the pipe, besides fusing the conductor solidly on to the pipe. (2) If the cable is withdrawn, the duct is rough at the point where the conductor has arced on to the metal, and this may injure the cable drawn in to replace the faulty one. (3) A draw-in system also ceases to be of much value for distributors, owing to the branch mains. (4) There are water and gas troubles, the gas not only being collected from the subsoil, but also generated by the fault. The troubles with bare strip in earthenware conduits caused by the formation of salts on the negative insulators do not appear where cast-iron duct is used. "Shorts" to the duct may be guarded against by slabs of porcelain laid at short intervals along the bottom of the trough. The longitudinal movement with heat of unstrained strip, if anchored at certain points, is prevented and the strip buckles towards either the top or bottom, or neighbouring conductors. The author concludes that the greatest risks of cables are, in the order of their importance: (a) electrolysis; (b) mechanical damage; (c) defects in manufacture and joints.

M. O'G.

1624. Conduit Wiring. F. Bathurst. (Elect. Rev. 50. pp. 584-587, April 11, 1902.)—The author advocates the general use of continuously earthing one pole and insulating the other, preferably by drawing a wire into an internally insulated screwed iron tube. The Armorduct system employs a 2½ in. diameter box which is so cast that, by knocking out one or more sides of the casting with a hammer, it can be used as a one, two, three, or four way outlet box. M. O'G.

1625. Four-Wire Three-Phase Systems as Applied in Modernising Central Stations. P. Junkersfeld. (West. Electn. 30. pp. 250-251, and p. 258, April 12, 1902. Paper read before the Chicago Electrical Association, April 4, 1902.)—The introduction of the rotary converter and the growth of high-tension transmission, have rendered it possible for crowded districts of a large city to be supplied economically by a low-tension distribution from one large central station and a number of substations with rotaries, installed in addition to the old steam plants, the latter being only worked during the peak of the load, for perhaps one or two months in the year. The cost of running in this way is found to be less than it would be to increase the capacity of the central station and dispense with the steam plant in the substations. Thus, not only is the "scrapping" of old generating stations rendered unnecessary, but the old plant is made, by the addition of the rotary, to answer as well as new apparatus. In the larger cities also it is commercially practicable to supply the tramways from the same source. In smaller cities, however, and scattered areas where single-phase alternating current has been installed, the limitations of the single-phase motor have made it necessary to replace the old single-phase by multiphase generators, and in such cases the four-wire three-phase system of primary distribution offers many advantages. Concisely stated, the advantages of this system of distribution are—(1) two available voltages, for light and power, from the same generator; (2) balancing of single-phase feeders; (3) the use of standard transformers throughout. The author describes fully the arrangements adopted for the various circuits, lighting and power, illustrating his description with plans and diagrams of connections, with special reference to the area in Chicago supplied by the Commonwealth Electric Co. Frequency changing sets are provided in substations, current being generated at 25 periods, and distributed from the substations at 60 periods over the four-wire three-phase system. For many isolated plants, the system (at low potential) could be employed with advantage, the generators delivering at either 440 or 220 volts between phases, for motors, and giving 250 or 125 volts, respectively, between neutral and phase, for lighting. If the isolated plant were situated reasonably near the central station, generating three-phase, there is virtually insurance against an extended shut down owing to accident, as the Company would probably be glad to give temporary help for a few hours, in the hope of obtaining a permanent customer.

Incidentally, the author discusses the question of frequency, and the desirability of compromising with 40 periods as a mean between the frequency of 25 cycles which is preferable for conversion to direct current, and that of 60 cycles which is required for general distribution for lighting, coming to the conclusion that such a compromise would be inadvisable. B. P. S.

1626. Italian Electric Power Transmission Regulations. (Elettricità, Milan, 21. pp. 180-188, March 23, 1902.)—These regulations, which have been drawn up by the Italian Electro-Technical Association, include, in addition to

internal wiring rules and regulations for providing against fire risks from electrical apparatus, regulations for the laying of underground cables and the erection of aerial lines with the precautions to be taken for protection against damage from lightning. They are based on a division into high-tension and low-tension lines, according to whether the voltage is greater or less than 350 volts for alternating, and 250 volts for continuous currents. G. W. DE T.

1827. *Electricity Supply Tariffs*. A. Wright. (Inst. Elect. Engin., Journ. 81. pp. 444-486; Discussion, pp. 486-531, March, 1902.)—The costs of supplying electricity may be divided into Preparation and Production costs. Preparation costs consist of—(1) Interest on the preliminary expenses; (2) annual cost of plant and maintenance of it, or the standing-by costs; (3) service costs. The Production cost is defined as the increment of expenditure incurred by making a given plant supply an extra unit of electricity. The author gives methods of separating these two costs from the monthly returns of the station, and shows that the Production costs are small compared with the Preparation costs. Another item of cost is the loss made in supplying a certain class of consumer. The best method of apportioning the standing-by charges to different consumers is by the indications of sluggish maximum demand indicators. An allowance, however, must be made for the fact that all consumers do not make their maximum demand at the same time. A fair allowance for this general diversity in the use of the plant is best made by dividing the annual standing-by costs per kw. demanded, by the ratio of the total of the consumers' individual demands in kw. during the month of maximum load, to the maximum load of that month, and debiting each kw. demanded by the consumer at this new rate. The author recommends that an annual load curve should be drawn for the station, by adding together the number of hours during which any given load has been supplied during the year, and plotting a curve between the percentage of annual maximum load and hours per annum. From this curve can be ascertained: the load-factor at which any proportion of the plant has been used; the ratio of the production and preparation costs at any load; the total cost of production at any load; the number of units sold at any load; the maximum losses economically allowable in the feeders; and what proportion of the plant should be equipped with condensers, economisers and other coal-saving apparatus. Examples of this curve are given for Brighton and Stepney, from which is prepared an analysis of the costs in the Brighton station, and a statement showing the sources of profit and loss. From the latter it appears that against 2,381 consumers who bring in a profit of £4,370, there are 524 who cause a loss of £1,855. Curves are given for Brighton and Nottingham showing the cost of supply to consumers having different load-factors. From these curves the best tariff can be seen. In Brighton this would be 12d. for the first 200 hours per annum and 3d. afterwards; in Nottingham it would be 8d. for the first 264 hours and 3d. afterwards. The greater part of the units sold are consumed by the class of small householders, and by shops, with the use of their lamps of 3 to 4 hours per day, and it is their interests which have to be specially consulted in fixing on a tariff. Large consumers should not be encouraged by a system of discounts, as they are often a source of loss. The author then discusses various systems of charging, and points out their defects, and concludes by giving formulæ for calculating the basis of charging on the maximum demand system. Discussion: R. A. Dawbarn pointed out that the use of maximum demand indicators entails considerable expense in first cost and in maintenance; that a flat rate is fairly applicable to 90 per cent. of

the consumers, and that it is not worth while incurring the expense of giving every consumer an indicator to accommodate a small percentage of consumers. **W. H. Patchell** said that in districts where there is competition the maximum demand system is at a disadvantage, as consumers prefer a flat rate that is fixed, to a system on which they do not know at what rate they will have to pay. **W. M. Mordey** referred to the difficulty in getting consumers to understand the system. He questioned the soundness of the principle; churches, for instance, are penalised by it, but when a church has a heavy load, the load on the houses of those attending the church is correspondingly diminished, so that the church cannot be said to increase the station load. The cost of the indicators in small installations is an important item, and the loss of pressure in them has also to be considered. He gives a table showing that the average load-factor of stations supplying on a flat rate is higher than that of stations using the maximum demand system. **J. R. Dick** referred to the adoption of Wright's system on the Continent and in America. He mentioned the case of a power company in Silesia, where the supply is made at cost price, and a charge made per kw. demanded. He deprecates the custom of offering supply at a flat rate or on the demand system at the option of the consumer. **L. Andrews** pointed out the difficulties that may arise from the irregularity of quarterly accounts made out under the demand system. He does not advise that it should be forced on consumers, but prefers to change a flat rate, and give long-hour consumers the option of reducing their bills by adopting the demand system. **R. H. Smith** traced out the four stages through which the system has passed. First, there was the Hopkinson scale of an annual charge per lamp, plus a charge per unit; second, the Wright plan of a charge per watt of annual maximum actual consumption; third, the plan of basing the charge on the quarterly instead of the annual consumption; fourth, the application of the diversity factor. Each change has been in the direction of flattening the scale. With the larger introduction of motors the scale will be still further flattened, and perhaps so much as to bring the Wright system down to the old flat rate system. G. H. B.

1628. Electricity Supply in Bulk. H. A. Earle. (Inst. Elect. Engin., Journ. 31. pp. 884-908; Discussion, pp. 908-923, April, 1902.)—The author commenced his paper by referring briefly to the following power schemes: Chèvres [see Abstracts Nos. 2506 (1900) and 579 (1901)], Niagara [see Abstracts Nos. 1193 (1900) and 2031, 2290 (1901)], Massena, Paderno [see Abstracts Nos. 681 (1901) and 995 (1902)], and Vizzola [see Abstract No. 460 (1901)]. In the light of the experience gained at these and other power stations abroad, the schemes of the English power companies cannot, in the author's opinion, be regarded as speculative ventures. The opposition which the promoters of the English schemes had to meet when obtaining parliamentary sanction was based, partly on the objections raised by local authorities, and partly on unfounded fears that the schemes would prove financial failures.

In order to show the fallacies underlying opposition of the latter class, the author has submitted to a detailed examination the prospects of the Yorkshire Electric Power Company's scheme for supplying the West Riding of Yorkshire with electricity in bulk. Within the area covered by the powers granted to this company there is a population of 2,500,000, and 1,000,000 of this total are outside the present area of supply by the eleven towns which have built and are now operating electric supply stations. It is also estimated that within the area covered by the company's Bill there are 27,000 factories and

workshops, utilising 2,000,000 h.p. The present scheme of the Yorkshire Electric Power Company is to erect four generating stations of 25,000 h.p. each. In view of the above figures, there should be little difficulty in finding the requisite number of power users to keep these stations running at their maximum capacity.

The author passes on to an examination of the Yorkshire scheme under the following heads: Board of Trade regulations. General system. Cost of generating stations. Cost of trunk mains. Cost of substations. Cost of distributing and service mains. Total expenditure and capital account. Works cost per unit generated, including management. Trunk mains, upkeep and superintendence. Expenditure at substations and upkeep. Distributing and service mains, upkeep and superintendence. Summary of expenditure per annum. Analysis of total units sold per annum. Total cost per unit sold. Rates of charge. Financial results.

The total capital expenditure upon the four generating stations, mains, transformers, &c., is estimated to amount to £2,666,666.

The running costs and total annual expenditure are calculated for an output of 140,000,000 units, with the following results:—

	Pence per unit.	Total.
Cost of Coal	0 128	£74,666
Oil, Waste, Water, and Stores	0 04	23,400
Wages and Station Staff	0 052	30,000
Repairs and Maintenance	0 05	29,167
Rent, Rates, and Taxes	0 05	29,167
Management, Directors' Fees, Salaries of Chief and Assistant Engineer, Office Salaries, Legal Expenses, Insurance, &c.....	0 025	15,000
Sinking Fund on four Generating Stations at £380,000 each—£1,820,000 at 3 per cent.	0 068	39,600
	<u>0 418</u>	<u>£241,000</u>

The Total Annual Expenditure being:—

Annual Expenditure at four Generating Stations, including Office Expenses, &c.....	£241,000
Trunk Mains	16,750
Substations	35,250
Distributing and Service Mains	24,750
Annual Expenditure	<u>£317,750</u>

The financial results show a profit of £248,250, as indicated in the statement given below:—

The total units per annum sold equal	123,700,000
Which, at a charge of 1½d. per unit, yields a gross revenue of	£567,000
The annual expenditure is	317,750
Leaving a profit of	<u>£248,250</u>
And this is equal to:	
4½ per cent. on £666,666 debentures	£ 30,000
and 10·9 per cent. on £2,000,000 share capital	218,250
	<u>£248,250</u>

J. B. C. K.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

1629. *Niagara Falls Power Transmission Plant.* (Amer. Inst. Elect. Engin., Trans. 19. pp. 241-258, March, 1902.)—This is a discussion on L. B. Stillwell's paper. [See Abstract No. 412 (1902).] The Author stated that improved regulation would be provided for the new alternators, which will ultimately be used for the long-distance service. Owing to the experience that fuses and circuit-breakers without some adjustable relay device might cause a short-circuit on a branch or a substation to interrupt the whole supply, a time-limit device was tried, circuit-breakers on branches from substations being set to open instantaneously, those at the terminal house connecting with substation supply cables, after one second, and those at Niagara controlling the transmission circuit, after three seconds. The arrangement was not, however, entirely reliable. Lincoln, after referring to the author's experiences as to the continuous depreciation of rubber cables by heat, stated that he had found a similar depreciation through continued static strain, and attributed this depreciation to the effect of the ozone which was produced under these conditions. Perrine, in reply to a question by Steinmetz, stated that on long lines he had, or protection against lightning, used a guard line of barbed wire, grounded through an earth plate at every fourth pole, which had the effect of keeping the line continuously discharged. When this was not employed, strong shocks were usually obtained on touching the line when idle. G. W. DE T.

1630. *New Generating Station at Rochester, N.Y.* (Power, N.Y. 22. pp. 1-6, Feb., 1902, and Elect. Rev., N.Y. 40. pp. 146-152, Feb. 1, 1902.)—The old plant has been replaced by a combined steam and water plant. The generating apparatus consists of six 1,860-kw., 2,500 volt, 60 $\sim$, 2-phase, 90 r.p.m. steam sets, and three 850-kw., 2,500, 6 $\sim$, 2-phase, waterwheel sets. The former are of the revolving field type. Two separate steam-driven 75-kw. exciters are provided. The engine-room has mezzanine floors, carrying the various steam-pipes, &c., and is on a lower level than the boiler-house. The Babcock & Willcox boilers are fed by Acme stokers. The boilers are each rated at 850 h.p., and have a heating surface of 6,500 sq. ft. Arrangements have been made for the future use of superheaters. The engines are of the vertical cross-compound type, by the Southwark Foundry and Machine Company, Philadelphia. The normal steam pressure is 160 lbs., and the consumption 18.5 lbs. per i.h.p.-hour. The internal variation of speed is $\frac{1}{4}$ of one geometrical degree from the mean. The governor controls both high and low pressure cylinders, and is of the Porter type. The King synchronising device is employed. Single throw oil switches are used. The instruments include polyphase wattmeters and power factor indicators. The cables are of the paper, lead-covered, duplex type, drawn into tile ducts. The substations are equipped with synchronous-motor-generator sets of 500 kw. and 75 kw. The low-tension cables are of the concentric paper type. The installation of such a high proportion of steam plant where water-power is available is justified by the promoters on the grounds that water-power is fitful and uncertain, and has to be utilised, in this case, at several points; and that with cheap prices the fuel is but a small proportion of the cost of production. [See also Abstract No. 719 (1901).] E. H. C.-H.

1631. *Overhead and Underground Railway in Berlin.* Langbein. (Zeitschr. Vereines Deutsch. Ing. 46. pp. 217-245, Feb. 15, pp. 261-272, Feb. 22, and

pp. 802-815, March 1, 1902.)—This railway, which was completed about the beginning of this year, runs through the southern part of Berlin from east to west, starting at the Zoological Garden and ending at the Warsaw Bridge. A short length is constructed in a double tunnel, about a mile long; the remainder of the line is carried through the streets by means of an overhead viaduct about 5 miles long. The first article is concerned with the description of the construction of the viaducts, tunnels, and permanent way. The rails used are of two kinds, one being 180 mm. high with sleepers 1.5 m. apart, used on iron viaducts, and the other 115 mm. high with sleepers 71 cm. apart, used with the ordinary ballast construction. Direct current is supplied at 750 volts from the power-house; the third rail, carrying the outgoing current, has a cross-section of about 8,600 sq. mm.; it is laid in lengths of 12 m. on vulcanite insulators and jointed with fishplates and copper bonds; it is laid 1,096 mm. from the centre of the track and 180 mm. above the level of the rails, except in the tunnels, where it is 50 mm. higher, in order to facilitate the switching on and off of the lighting circuits. The pressure at the further end of the line amounts to 660 volts; the station lighting is therefore carried out at this pressure, series resistances being inserted at those stations near the power-house; either 12 arc lamps in series or 8 incandescent lamps in series are used. The power-house is nearly in the middle of the line. There are 6 water-tube boilers, each with 290 sq. m. of heating surface; they are provided with superheaters, giving a steam temperature of 225° C. at a pressure of 10 atmospheres. There are two steam feed-pumps, each supplying 40 cubic metres per hour. The engine-room is on the ground floor, the boilers being arranged overhead. The chimney is 80 m. high and 8.5 m. in diameter, but as the boilers are 15 m. above the ground level the available height of the chimney is only 65 m. The engine-room is divided by iron columns into two halves, and is traversed by two electric cranes of 15 and 20 tons capacity respectively. The plant includes three 800-kw. steam sets running at 115 r.p.m. The engines are of the vertical compound type, with cylinders 800 mm. and 1,270 mm. in diameter, and 750 mm. stroke, giving normally 900 h.p. with a steam pressure of 9 atmospheres and an overload of 1,200 h.p. The flywheels weigh about 83,000 kg. The dynamos are shunt-wound and give 800 kw. at 750 volts. The battery is capable of giving 800 kw. for one hour. Each train consists of three coaches, each of which has seats for about forty passengers and standing room for thirty more. The front and back carriages carry three motors each, fitted in the bogies, there being room, however, for four if they should be found necessary. The maximum speed is 50 km. per hour. Brakes operated by hand or by pneumatic pressure are ordinarily used, but in emergency a short-circuiting brake can be applied. On each side of each carriage there is a current collector; so that each train has in all six collectors. The line is said to have cost £150,000 per km., including expenses of all kinds, while the Metropolitan Railway in Paris cost £175,000 and the Central London Railway £375,000 per km. The articles contain a large number of drawings and illustrations of all kinds, 150 in all. W. H. S.

1932. *Wallasey Electric Tramways*. (Tram. Rly. World, 11. pp. 217-221, April, 1902.)—These tramways cover about 8½ miles of road with 10½ miles of single track. The route is mostly comparatively level, but there is a short gradient of 1 in 14. The rails weigh 98 lbs. per yard, they are in 60-ft. lengths, they are 7 in. wide and 7 in. deep. Flat sole-plates ½ in. thick are used at the joints. Chicago bonds are used. The trolley wires are

of 000 gauge, and Gouble wires are used throughout. Ten miles of feeders, varying from 0.2 to 0.4 sq. in., have been laid. The generating station contains four Lancashire boilers 28 ft. by 7 ft. 6 in., and one Babcock and Wilcox boiler. A Green's economiser of 256 tubes is employed. The station contains five Ferranti alternators, ranging from 75 kw. to 800 kw. direct coupled to Ferranti and Browett and Lindley engines. The traction plant consists of two 800-kilowatt 6-pole generators 10 per cent. over-compounded, driven directly at 320 r.p.m. by two vertical compound engines, built by Messrs. Galloway, who have also built the separate condensing plant.

A. E. L.

1633. *Burnley Electric Tramways*. (Tram. Rly. World, 11. pp. 199-210, April, 1902.)—These tramways cover about $7\frac{1}{2}$ miles of route laid with a 4-ft. gauge. The gradients are severe, the steepest being 1 in 16 for a distance of about 50 yards. The smallest curve-radius is 70 ft. The rails weigh 102 lbs. per yard; they are in 60-ft. lengths, are 7 in. wide at the base, and $8\frac{1}{2}$ in. at the head. The groove is $1\frac{1}{4}$ in. wide. The specification required the following analysis: Carbon 0.4 per cent., phosphorus not more than 0.08 per cent., silicon 0.15 per cent., sulphur 0.06 per cent., manganese 0.1 per cent. In addition to fish-plates 24 in. long, weighing 38 lbs. per pair, anchor-plates of similar section to the rails are used at each joint. Both Crown and Edison-Brown bonds are used at each joint, and the rails are cross-bonded every 50 yards. The trolley wires are carried by centre bracket poles, side bracket poles, and by span wires in different parts. There are two feeders, supplied by the British Insulated Wire Company, and drawn into Sykes' patent conduits. The generating station contains five Lancashire boilers 7 ft. by 28 ft., with two Proctor and one Leach mechanical stokers. There are two Green's economisers, one of 190 and one of 120 tubes. The coal consumption is about 6 lbs. of slack at 9s. 8d. per ton per kw.-hour delivered. Three horizontal compound condensing engines, two of 150 h.p. each and the other of 200 h.p., drive by ropes two-pole dynamos, giving 440 volts for lighting and 550 volts for traction. There are also two new direct-coupled sets, consisting of 450-h.p. Belliss engines and E.C.C. dynamos. A Tudor battery, capable of giving 40 amperes for one hour, is used in conjunction with Highfield boosters. There are twenty-four cars 38 ft. 10 in. long over all, and weighing, with their maximum traction trucks and two 87-h.p. motors, 12 tons each. The average energy required per car mile is 1.4 kw.-hours.

A. E. L.

ELECTRIC TRACTION AND AUTOMOBILISM.*

1634. *Deterioration of Steel Rails*. T. Andrews. (Engineering, 73. pp. 501-504, April 18, 1902.)—About 12 ft. of Bessemer steel rail, which had stood the main line traffic of an English Railway Company for fifteen years, was submitted to the author, who gives the results of careful external examination, chemical analyses, physical tests, and high-power microscopical observations. The rail had suffered loss in weight amounting to about 1.15 lbs. per yard per annum, partly due to corrosive influences, but mainly attributable to the great excess of sulphur and phosphorus, which impurities in excess induce a more rapid disintegration of steel rails. The corrosive effects were much more marked where the rail had lain in the chairs, due to the

* Non-electrical Automobiles are described in the section dealing with steam and gas engines.

fact that galvanic action arises between the cast-metal chair and the steel rail when in a damp condition. Local segregation of the chemical constituents had also occurred to some extent, and had it not been for the comparatively low proportion of carbon and manganese, the author considers the rail would never have stood so long. The high-power microscopical examination showed the general structure of the rail face to be fairly good, but an examination of a section immediately below the surface showed the steel to be honeycombed with innumerable micro-flaws (caused chiefly by the excess of impurities) which undermined the rail, and were capable of developing to any extent, and would undoubtedly have soon led to the fracture of the rail.

The results point to the necessity of careful chemical analyses and physical tests in ordering new rails, and also of carefully watching those in use, and removing them as they show signs of excessive deterioration.

C. E. A.

1635. *Electric Railway Practice and Apparatus*. (Amer. Inst. Elect. Engin., Trans. 19, pp. 278-306, March, 1902.)—This is a discussion of papers by A. H. Armstrong and E. J. Berg [see Abstracts Nos. 418 and 419 (1902)]. After some remarks by G. Gillon and Janisch on the Berlin-Zossen experiments [see Abstracts Nos. 598 and 797 (1902)], B. J. Arnold expressed his belief in the future of the alternate-current motor for railway work, and suggested that the example of a line selected by E. J. Berg was exceptionally favourable to the continuous-current one. If a somewhat longer line had been selected, he suggested that the figures might have been modified, and stated that the alternate-current motor appeared to him the ideal thing for heavy, long-distance railway work at high speeds, and that he looked to the manufacturing engineers of the country to solve this problem. Mailloux considered that the alternate-current motor was, under existing conditions, practically precluded from use for high-speed service on short runs, subsequently explaining that by high speed he meant a schedule speed of 45 to 50 miles an hour, involving car speeds of from 60 to 80. The alternate-current motor was not as good as the continuous-current one for high-speed rapid transit service, for the reason that initial angle or mean rate of acceleration could not become as high with the former as with the latter. This was due to the fact that, at present, alternate-current motors can develop a maximum starting torque of from two and a half to three times the normal full load torque only, whereas a continuous-current motor can develop a maximum, which may reach as high as from six to ten times the mean effort. His investigations had so far led him to the conclusion that it is impossible, in relatively short runs, to obtain a mean angle of acceleration sufficiently steep, with the alternate-current motor, to give the schedule time required for high-speed service. If the run is sufficiently long this can be done, but for runs up to a mile and a half, or perhaps more, the difficulties of obtaining a sufficiently high rate of acceleration are too great for the existence of any hope of an immediate solution being found. G. Gillon observed that, in the transformer motor-car, the starting torque of three-phase motors could be increased at will by raising the e.m.f. at their terminals by means of a few supplementary winding turns. This was more especially possible in the secondary of the transformers, inasmuch as the starting torque increases in proportion to the square of the applied e.m.f. E. P. Roberts called attention to the case of through and local service on the same line, and expressed the hope that it might become possible to eliminate the sub-

stations, with the corresponding interest, repair and depreciation accounts for the investment in rotating machinery, and the salaries for attendants. Capitalising salaries and adding to the cost of machinery makes the total first cost of substations a very considerable percentage of the total cost of an interurban electric railway, and a great increase per mile as compared with 10 to 15 mile continuous-current lines. He did not consider it probable that substations could be dispensed with on the ordinary interurban line, except by so increasing the fuel cost of the generating machinery, line work, and car equipment, as to more than offset the advantage gained. He gave the following table, embracing the results of measurements of 500 miles running over four lines, of cars each provided with four 50-h.p. motors of about the same size and weight, but differing in gearing, maximum and schedule speeds, number of stops per mile and grades of line. No. 1—high schedule and maximum speeds, level line; No. 2—medium schedule speed, level line; No. 3—medium schedule speed, considerable grades and curves; No. 4—medium schedule speed, heavy grades and curves; the schedule speed being exclusive of the lay-over at the end, and the kw. being taken at the car.

	Speed.			Average stops per mile in Country.	Kw. per Mile		Average kw.	
	Schedule.	Maximum.	Running.		In Country	In City.	In Country	In City.
No. 1	26.2	55	41	0.85	2.88	2.11	73.8	21.1
No. 2	20.5	48	32	1.41	2.85	2.27	56.8	21.6
No. 3	20.4	39	25	0.70	2.18	3.36 ¹	48.5	26.5
No. 4	20.6	47	24	0.56	2.18	2.32	47.8	23.4

¹ Unusual load and stops.

The maximum current was 400 amperes in No. 1, starting, and No. 3, accelerating on grade. The maximum grade in No. 3 was 12 per cent. for about half a mile, taking 15.7 kw. per car mile. He referred to the problem, in designing new lines with traffic yet undeveloped, of the greater initial economy of providing fewer substations, with heavier feeders, while with increasing traffic it became more economical to have lighter feeders and more frequent substations. **Stillwell** pointed out that a limitation of the substation plan, which plays an important part in heavy town lines, is to be found in the fact that a reserve of machinery is required at each substation. For example, in the case of the Manhattan Railway, seven 5,000-kw. alternators take care of the maximum load, with one in reserve. Seven substation equipments consist of twenty-six 1,500-kw. converters, with seven in reserve, giving a total of 40,000-kw. capacity for the power plant, and 49,500 in the substations. High acceleration is imperative in large towns to secure the maximum speed, and consequently, the maximum passenger-carrying capacity; but it is limited in practice by the fluctuating over-loads on the sub-station apparatus, which, in the case of numerous sub-stations, equalise each other, to a large extent, at the power-house. For example, some calculations for eight-car express trains, running on two minutes' headway, appeared to show that the increase of load on the rotary converters in a sub-

station might amount to as much as 10,000 h.p. in three seconds, coming up to rolling mill practice. This serious difficulty would be eliminated if alternate-current motors could be employed. If this development were effected, it could hardly be expected to increase the 80 per cent. efficiency from engines to motors with substation converters to more than 90 per cent. Now the power bill is about 80 per cent. of the operating expenses, or, on the average, about 18 per cent. of the gross receipts, in the case of American elevated railways. This would only effect a saving equivalent to 2 per cent. on the income, not sufficient to justify an experiment on a large scale, and this sufficiently accounted for no stronger efforts having been made in America to solve this problem. He considered, moreover, that if this gain could be effected, it would be more than counterbalanced by the risk attending the use of high voltage in large towns, except perhaps in tunnels. **E. P. Roberts** mentioned a case in which three cars running at high speed gave fluctuations of as much as 1,000 amperes at the continuous-current switchboard, and suggested that, in such cases, the question of using secondary batteries deserved serious consideration. **Steinmetz** stated that, in every case he had investigated, he had come to the conclusion that the transmission efficiency of the three-phase system would be lower than that of the continuous current, owing to the comparatively low efficiency of the induction motor under service conditions. The load fluctuations would be increased by eliminating the converter by the introduction of three-phase motors, for the torque increases with the current at a much higher rate with a continuous-current series motor than with an induction motor, and, moreover, the static transformers used with the latter will not stand overloading to anything like the extent possible with the converter. As regards reserve machinery, the elimination of the converter may in many cases greatly increase the necessary reserve capacity, and this will be continuously in circuit in the form of static transformers, for a small line loss is essential to avoid a heavy drop of voltage with the excessive starting current; otherwise an excessive overload motor capacity would have to be provided, with consequent very low efficiency and small power factor under normal conditions. **Scott** stated that he had obtained figures very closely agreeing with those of **Berg**. The braking advantage of induction motors, he considered, was more than counterbalanced by the increased motor weight necessary if they were to be so used. In order to obtain the maximum advantage in braking it is necessary to begin braking at the highest speed. The energy which might thus be returned to the line could be much better employed in slightly changing the conditions, and using it for overcoming friction by drifting. Electric braking cannot be effected below half speed, and in many cases it will be possible to drift down to this, or lower. The constant speed of the induction motor on varying grades was claimed as an advantage. His point of view was that this was a serious limitation to the speed, the continuous-current motor, by its capability of variation, giving a much higher average speed. **Steinmetz**, in reply to a remark by **Stillwell**, stated that the advantage claimed for the induction motor of returning energy in concatenation during retardation, is one not borne out by numerical investigation. Running at synchronism until braking begins, the most wasteful method of working, such a return of energy is obtained. As **Mailloux** had pointed out, however, the proper method of working under rapid transit conditions, that is, the way to carry the motor in a given time over a given distance, with the minimum expenditure of energy, is to accelerate, as fast as possible, to high speed, then shut off the power and

drift until the time for braking arrives, as this devotes to necessary operation a large part of the energy otherwise dissipated in braking. Now, with the three-phase motor, where the maximum speed is slightly below synchronism, and drifting is begun at this speed, at the end of the drift the speed will have fallen to nearly the half, and it is only above half-speed that energy can be returned. The induction motor as an electric brake for returning energy is, therefore, unsuitable for rapid transit work. Concatenation to start and attain half-speed is correct, but even then the efficiency is inferior to that of a series controlled continuous-current motor. Two concatenated motors are lower in efficiency than two continuous-current motors in series, the current of the first motor being in excess.

G. W. DE T.

1636. *Westinghouse Magnetic Brake for Tramcars.* (Mech. Eng. 9, pp. 626-628, May 10, 1902.)—The brake consists of a horse-shoe magnet, suspended by spiral springs from the car frame, the two poles hanging down directly over the rail. The short-circuited motor current is passed round the exciting coil of the magnet, the result being that the poles are drawn downwards by the steel rail. The poles are fitted with soft iron shoes, which grip the rail, the whole forming a kind of slipper brake. The poles are also connected by levers which apply a brake to the wheel rims. Various forms of braking action are therefore applied at the same time by moving the handle of the controller beyond the "off" position in the opposite direction to that which starts the car.

W. H. S.

1637. *Electric Heating of Trains.* J. A. Montpellier. (Électricien, 23, pp. 225-226, April 12, 1902.)—On the electric railway to Versailles a system of electric heating has been adopted in the carriages which has given satisfaction. In each of the carriages, which are of the central corridor class, ten heaters are placed on the floor between the seats, so that they act as foot-warmers. The heaters are of the Parvillée construction, in which the resistance consists of a mixture of a metallic powder, quartz, kaolin, and a flux [see Abstract No. 908 (1899)], and are connected five in series—being supplied from the third rail at 550-600 volts. At 110 volts each takes 1 ampere, and the total power for each carriage, which seats forty passengers, is therefore 1,100 watts. Assuming a cost of 15 centimes per kw.-hour, it follows that the expense of sixteen hours' use will be 2.64 francs. The mean temperature measured at the surface of the heaters is 70° when the external temperature is 0°. It is claimed that the method is more convenient and less expensive than other systems.

W. W. H. G.

1638. *Railway Signalling.* (Engineering, 78, p. 184, Feb. 7, 1902.)—An invention of J. Netter and H. Queyroul consists of a thin copper wire held between two arms over the engine cab. The wire is broken on coming into contact with a rod extended from the line signal. This opens an electric circuit, and works a signal disc and alarm-bell inside the cab, thus apprising the driver of "danger." For running through tunnels and under low-arched bridges the arrangement is automatically lowered and then raised again, as follows: Two metallic brushes are fixed under the engine, and old rails are placed between the track rails, one in front and one behind the tunnel or arch, in such a position that one brush is earthed on one side, and the other on the other side, of the place where the bow has to be lowered and again raised. By means of a small 20-volt and 12-ampere-hour accumulator on the engine, an electromagnet is caused, when one brush is to earth, to pull down the bow by moving an iron core, and when the other

brush is earthed, a second electromagnet operates in the same fashion to restore the bow to normal position. While it is down, an alarm-bell is kept ringing. Drawings of the apparatus are given. It has been tested on express trains running at maximum speed, and has worked satisfactorily. The broken wire is easily replaced while the train is running. E. O. W.

1639. *Russian Electric Block-Signalling*. (West. Electr. 80. p. 386, May 31, 1902. From *Elektrotechnik*, St. Petersburg.)—At the Moscow Convention of electrical engineers the following block system was considered the best device submitted to meet the conditions of the problem set for examination. The contacts of the rails are to be utilised. They shall work only when a train passes, and must not be actuated when only a hand-car passes, or the road-bed is shaken by work going on near by. The contact must be long enough and good enough for the current to operate the necessary apparatus. The contacts must not be affected by atmospheric conditions. Constructions, repairs, and maintenance of the contacts must be easy. The device described depends upon the deviation of the rail, or its ductility under a train. It begins to bend under the first wheel, and there is thus time during the passage of the whole train for the bending to take effect at the electrical contact. A beam of iron is fastened on two adjacent sleepers. In the middle of the space between the sleepers a box is fastened vertically to the beam. This box contains an arrangement of levers required for the transmission of the motion and for the formation of a contact. There is an opening for a cable, and another for a pin which is set vertically, and rests at its lower end upon a brace connected to the base of the rail. The pin descends when the rail is bent, and an electrical contact takes place inside the box, bringing the cable into circuit. Thus a signal can of course be operated. The pin and cable holes in the box are presumably watertight. In case the pin should rise above its normal position, by temperature changes, &c., it pushes the contact "off" and not "on," and no fault is therefore likely to happen. E. O. W.

1640. *Block-signals for Single-line Railways*. L. Kohlfürst. (Elektrotechn. Zeitschr. 23. pp. 240-242, March 20, 1902.)—In this system, which is in use on the Buffalo-Lake Erie Railway, there is arranged, at each end of the single-line section, a box having three superposed compartments. The uppermost of these compartments contains two incandescent lamps showing a white light, the middle one contains two incandescent lamps showing a red light, whilst the lowermost, one contains a two-point switch, to which access can only be had by the guards of the trains using the line. These switches are so constructed that they cannot remain in an intermediate position, and are connected up with a live wire extending along the single-line track, with the said lamps and with the earth, in such a manner that when the guard, on his train entering the section, turns the switch from one point to the other, a white light will appear at one end and a red at the other; when, however, the train reaches the other end of the section, the guard turns the switch at that end, whereby the lamps at both ends are extinguished, and the line is again clear. Various modifications are described, and several diagrams of connections are given in the original paper. C. K. F.

1641. *Automatic Electric Block-signals*. L. Kohlfürst. (Zeitschr. Elektrotechn., Wien. 20. pp. 81-85, Feb. 16; and pp. 112-115, March 2, 1902.)—In this paper, the whole question of electric block-signals is discussed, both

with respect to European and American practice. The following points are considered, viz.: The conditions to be fulfilled by block-signals; the relative advantages of the various kinds of signals (disc, semaphore, &c.); the numbers of the different kinds of signals installed each year in the United States; the results of tests made on the Chicago and N.W.R.R.; a list of the obligatory and optional conditions prescribed for block-signals by the American Railways; the results of working the Hall system of electric block-signals on the Chicago and N.W.R.R. The costs of working the last-mentioned signals are as follows: Each electrician at \$75 per month supervises about 40 signals on a 82-kilometre section of line. Each battery-attendant at \$45 per month looks after the batteries at 20 signals, and assists the electrician. Each lamplighter at \$80 per month, attends to the lamps at about 20 signals, and assists the battery-attendant when required. The electrician inspects his section twice a day, and overhauls each signal once a month. The mean costs of maintaining and working each signal in 1898 was \$83.61, apportioned as follows: Labour and material for the signal, \$82.83; for the battery, \$30.42; and for the lighting, \$20.86. The resistances of the lines and instruments and the currents taken thereby are also given. E. C. Carter, the general manager of the railroad, describes the system as trustworthy when properly installed and carefully maintained. [See also Abstract No. 1219 (1901).] C. K. F.

1642. *Electric Train Signalling System.* R. Bartelmus. (Zeitschr. Elektrotechn., Wien. 20. pp. 129-132; Discussion, p. 132, March 9, 1902.)—In this system, a single contact-rail is arranged in the middle between the two running rails throughout the line. This contact-rail is interrupted every 200 m., these interruptions being each bridged by a resistance of 1 ohm. On the locomotive is mounted a direct-driven shunt-wound dynamo giving 60 volts. One terminal of the dynamo is connected to the frame of the locomotive, and the other to a contact-loop which slides over the central third rail, the circuit including various electromagnetic indicators and switches. As this locomotive approaches a short-circuit or connection between the running and third rails, the current in the dynamo circuit gradually increases, and successively shows a green light, an audible alarm, and a red light on the locomotive, and finally automatically closes the steam-valve. Signals can also be given on a locomotive without a dynamo. Signals can be given to the locomotive from the separate carriages by short-circuiting the running and contact rails. Modifications are also described in which the indicating devices are arranged at stations and in signal-boxes, and are connected across the interruptions in the third rail. C. K. F.

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1643. *The New York Rapid Transit Subway.* C. Prelini. (Engineering, 72. pp. 477-480, 507-510, 547, 576-577, 637, 674-676, 699-700, 737-740, 763-765, 857-858, Oct. 4 to Dec. 27, 1901; and 73. pp. 11, 40-44, 112, 141-143, 205-208, 245-246, 276-277, 364-365, 429-430, 464-466, Jan. 3 to April 11, 1902.)—These papers contain a very comprehensive and detailed description, with numerous illustrations, of the construction of this important undertaking. [See also Abstract No. 793 (1902).] G. W. DE T.

1644. *The Telephone in Railroad Work.* M. Garl. (American Telephone Journal, 5. pp. 34-36, Jan. 18, 1902.)

TELEGRAPHY AND TELEPHONY.

1645. Effects of Contacts upon Telegraphic and Telephonic Currents. J. de Pauw. (Soc. Belge Élect., Bull. 19. pp. 9-11; Discussion, pp. 11-14, Jan., 1902.)—When two wires covered with oxide are in contact, telephonic conversation is not interfered with; and when the oxide is thick enough the alternate currents from a magneto are also obstructed by it. The author views the oxide of copper as a dielectric, for both undulatory and alternating currents. He quotes a case on the line from Brussels to Paris where, during a contact, telephonic communication was good, but telegraphic indifferent. A similar effect was noticed during a thick frost when the wires were in contact between Leuze and Tournai. The frozen particles acted as a dielectric in the one case and as a conductor in the other. Several speakers quoted cases where telephonic circuits, even 7 km. in length, laid on ice or dry snow, have been successfully operated—at Ixelles, Mt. Blanc, and St. Bernard, for instance. Here the insulating property of snow and ice comes into play.

E. O. W.

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- 1646. New Equipment of Chicago Fire-alarm System.** (West. Electn. 30. pp. 91-92, Feb. 8, 1902.)
- 1647. Glasgow Corporation Telephone Exchange.** (Elect. Engin. 28. pp. 330-334, Sept. 6, 1901.)
- 1648. New Transmitter of the German Post Office. J. Baumann.** (Électricien, 22. pp. 161-164, Sept. 14, 1901.)
- 1649. Changing a Magneto Drop to a Central Battery System. C. L. Goodrum.** (Elect. World and Engineer, 38. pp. 547-548, Oct. 5, 1901.)
- 1650. Recent Common Battery Telephone Exchange Work in New York City. H. L. Webb.** (Elect. World and Engineer, 38. pp. 925-928, Dec. 7, 1901.)
- 1651. Telephone Exchange System of the Maryland Telephone and Telegraph Company. K. B. Miller.** (Elect. World and Engineer, 38. pp. 921-925, Dec. 7, 1901.)
- 1652. Hotel Telephone Exchanges in Chicago.** (West. Electn. 29. pp. 381-382, Dec. 14, 1901.)
- 1653. The Bell Telephone Company's Central Energy System. W. S. Henry.** (Amer. Electn. 14. pp. 36-38, Jan., 1902.)
- 1654. Independent Telephony at Charleston, W. Va.** (Elect. Rev. N.Y. 40. pp. 274-275, Feb. 22, 1902.)